CIMEE'23

# 5th International Symposium on Materials, Electrochemistry & Environment

21 - 23 September, 2023
LEBANON

## Theme: Green Chemistry and innovative Technology Towards a more sustainable environment


## BOOK of ABSTRACTS & PROGRAM

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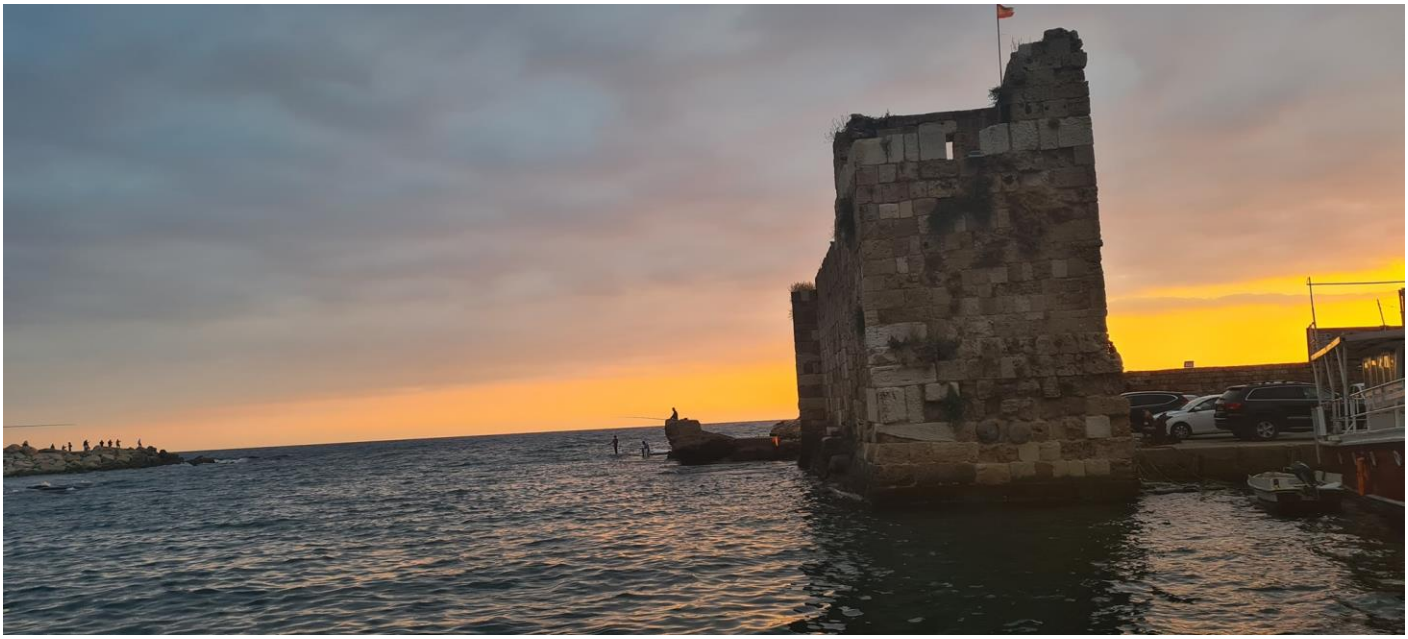
**BOOK OF ABSTRACTS, FIFTH INTERNATIONAL SYMPOSIUM, CIMEE23**

# C I M E E

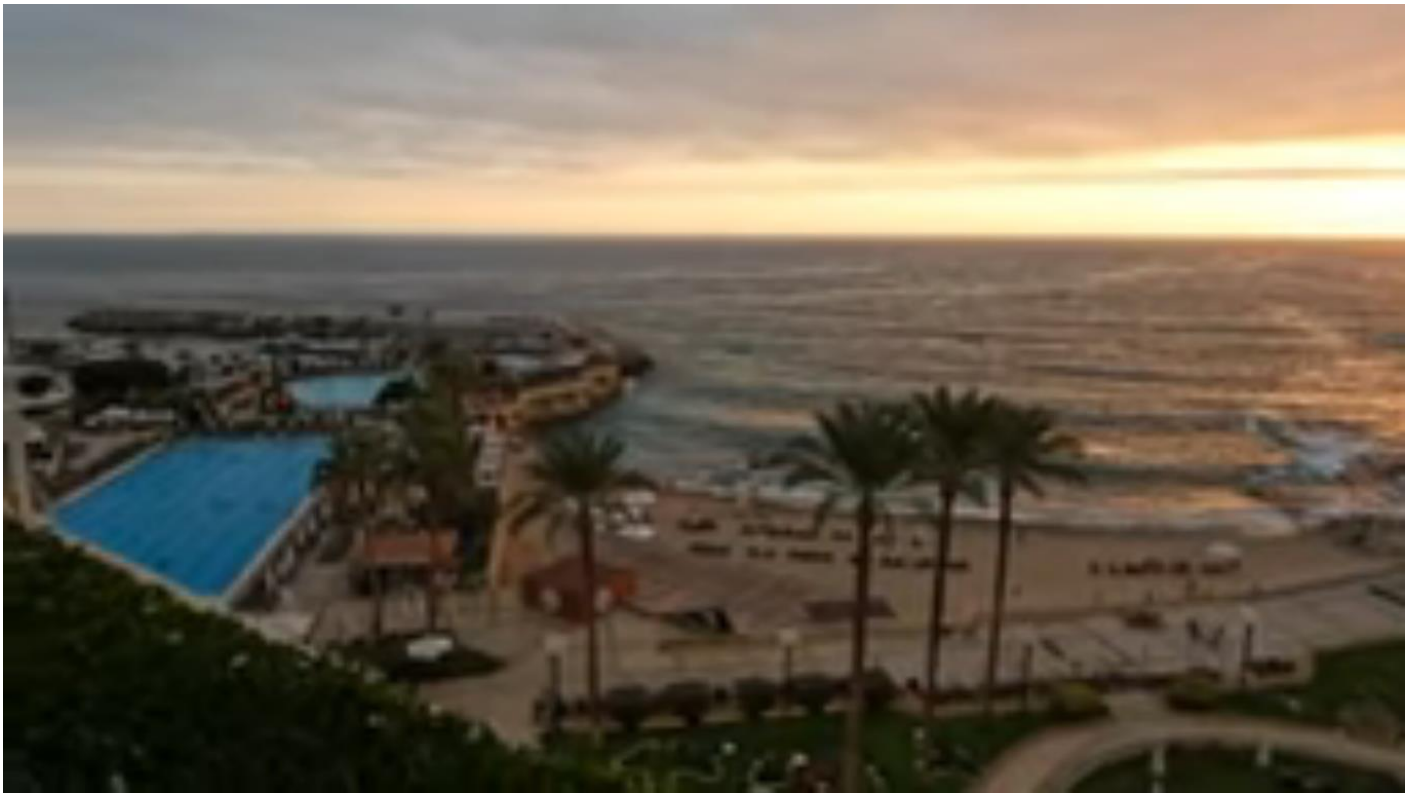
INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

# C I M E E

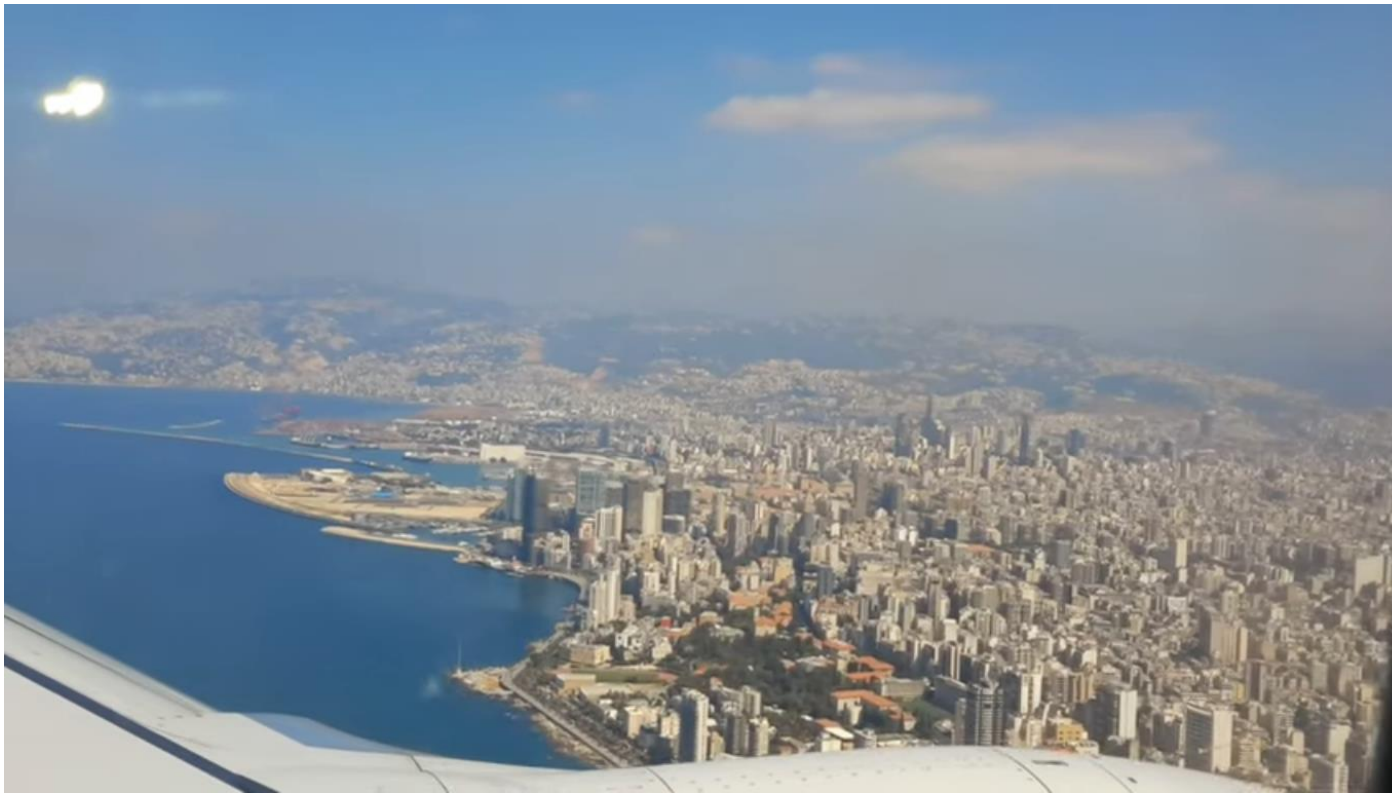
## INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT



# MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT



## CIMEE'23 LEBANON, SEPTEMBER 21-23, 2023



THE WORLD EVENT IN INNOVATION CHEMISTRY & SUSTAINABLE ENVIRONMENTAL REMEDIATION

CIMEE23, GREEN CHEMISTRY AND INNOVATIVE TECHNOLOGY TOWARDS A MORE SUSTAINABLE ENVIRONMENT

## SYMPOSIUM PARTNERS

- **Laboratory of Applied Chemistry & Environment, National School of Applied Sciences, ENSA, University of Ibn Zohr, Agadir, Morocco**
- **Laboratory of Electrochemistry, Molecular Engineering and Redox Catalysis, Faculty of Technology, University of F. Abbas Sétif-1, Algeria**
- **Center of Materials Technology and Photonics, Hellenic Mediterranean University, Heraklion, Crete, Greece**
- **Laboratory of Environmental Engineering and EcoTechnology, National School of Engineering of Sfax, ENIS, University of Sfax, Tunisia**
- **Department of analytical Chemistry, Faculty of Pharmacy, Ankara University, Turkey**

**With the support of Agence Universitaire de la Francophonie, AUF**

# WELCOME MESSAGE FROM THE SCIENTIFIC COMMITTEE CHAIR

## CIMEE23, SCIENTIFIC PROGRAM

Scientific Program

**THEME: GREEN CHEMISTRY & INNOVATIVE TECHNOLOGY TOWARDS A MORE SUSTAINABLE ENVIRONMENT**

Dear all,

We take an immense pleasure to extend our warm welcome to invite all the participants from all over the world to attend new edition of the series of international symposium on Materials Electrochemistry and Environment, CIMEE 23 during September 31-23, 2023 at Tripoli, Lebanon

The theme is **Green Chemistry and innovative Technology Towards a more sustainable environment**

**T**he 5th International Symposium, CIMEE23, will provide an excellent platform for fruitful research exchange with a focus on the application of physical and physical chemistry, biological, geochemical, practical, theoretical chemistry in interdisciplinary research and innovations. During the CIMEE23 conference in Lebanon a number of invited internationally recognized scientists will highlight the topics. Moreover, grand number of contributed talks will be presented in the focused sessions.
The conference will consist of an opening session with a panel discussion, topical sessions with keynote addresses and oral contributions, e-poster sessions and side-events. Each session will begin with a keynote address to frame the intended message, followed by presentations from relevant and knowledgeable experts, and ending with a round table or panel discussion. Depending on the number of abstracts received, poster sessions will also be organized to support each session.
The closing session will be structured as a plenary to highlight the main conclusions of the conference. It will be led by the Conference Chair with closing remarks from the Technical Programme c committee.

# WELCOME MESSAGE FROM THE PROGRAM CHAIR

## Message from the Program Chairperson

Over the years, great progress has been made in the fields of materials, electrochemistry and the environment to help improve and modify the environment around us. However, some of these improvements include many techniques and strategies that call for actions to protect many aspects of life on earth: water, agriculture and energy and looking towards a better and sustainable environment.

We, as scientist and researchers, continue to rise to the challenge of developing environmentally sustainable solutions for all aspects of the life. The International Conference on Materials, Electrochemistry and Environment, CIMEE'23 seeks to bring to light all field of chemistry innovations, with particular attention given to those solutions to the greatest challenges in sustainability.

The CIMEE'23 develops solutions based on novel and hybrid materials, advanced techniques in electrochemistry while reintroducing analytical chemistry, agricultural chemistry and geochemistry to provide sustainable solutions for the environment. In the meantime, this event will remain the ideal event to share chemical applications for the environment such as: environmental management, groundwater and surface water protection, soil protection, cleaner production and waste management.

The CIMEE'23 Program Committee invites paper proposals showcasing the technology advancements and looks forward to all participation et contribution in this edition, CIMEE'23.

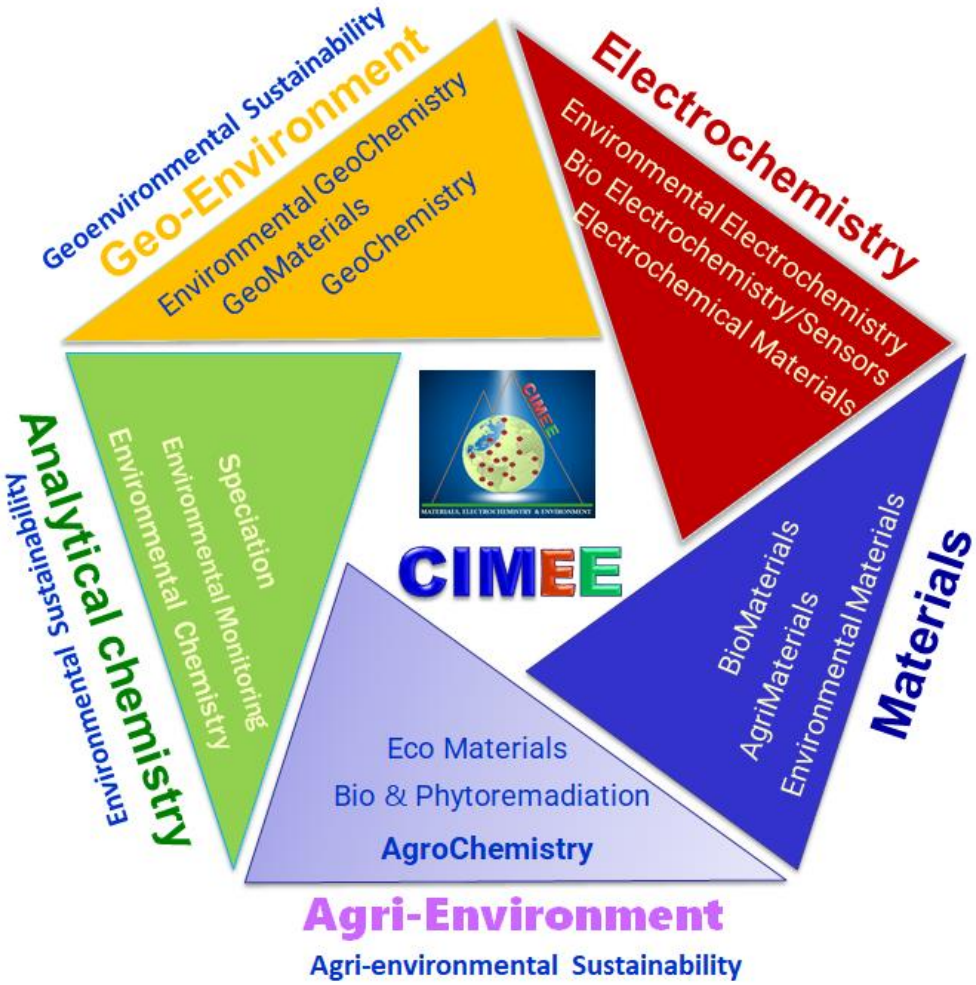
*Program Committee Chairperson*
*ElMoll Ahmad*

## WELCOME MESSAGE FROM THE CONFERENCE CHAIR

Dear Distinguished Colleagues,
The conference theme, "Green Chemistry and innovative Technology Towards a more sustainable environment" has been carefully chosen with the aim of saving resources in raw materials and energy and respecting the environment and the well-being of consumers. In this edition we will try to explore all avenues for developing plant chemistry both as a source of raw materials and as a source of energy as well as the development of biotechnology tools and sustainable and bio-sourced processes. Also explore the prevention of waste formation, the economy of atoms, the use of non-toxic substances and renewable raw materials and the reduction of the impact on the environment.

At this conference, we will listen to guest speakers to mainly address topics relating to the treatment and recovery of waste, use of advanced electrochemical processes as well as materials for the environment. Additionally, this conference will be one for us to share our thoughts and exchange ideas on how to chart our journey forward to reach new heights in the field of chemistry and environmental chemistry. We have an exciting program lined up with eminent speakers spanning across the globe. This conference will allow members to reflect upon and jointly explore current and future research directions, renew friendships and extend networks.
We hope that you will have a productive and fun-filled time at this very special conference. To convene a conference of this magnitude is not a small task and the success of the conference ultimately relies on the many people who have worked with us tirelessly in planning and organizing both the technical program and supporting social arrangements.
We would like to thank all the supporting organisations for shouldering the responsibility and playing co-host at this conference.

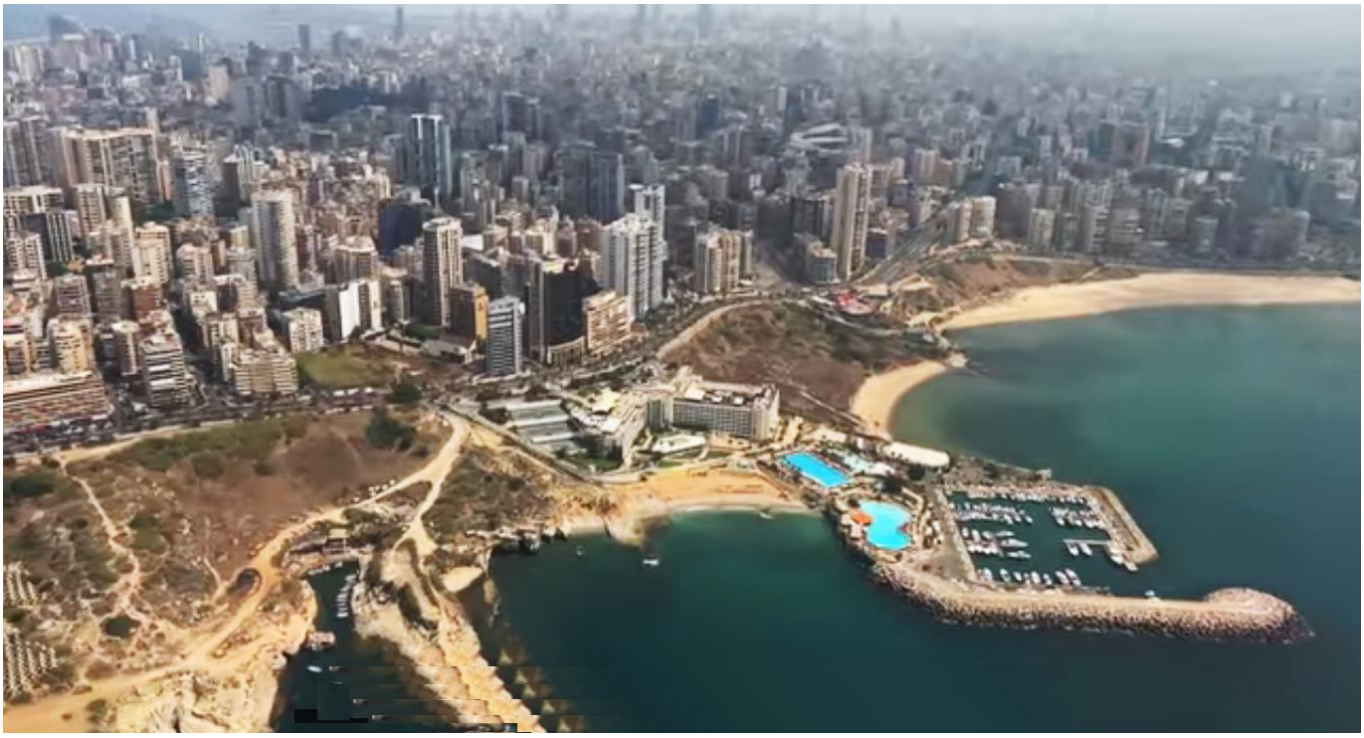
Our heartfelt thanks to all our respected partners for contributing in the preparation of this edition.



# SCIENTIFIC PROGRAM

We have the honor to invite more than 30 distinguished experts as speakers to present their speech.
The event has the objective of creating an international forum for academics, researchers and scientists from worldwide to discuss worldwide results and proposals regarding to the soundest issues related to Materials/Nanomaterials, electrochemistry and Environment.
All of them reached very high scientific levels, giving to all the participants the opportunity of listening to the most celebrated world speakers presenting state of the art advances in chemical sciences and to discuss openly with the chemistry community.
We're pleased to announce the scientific program with several of Plenary, keynote and invited speakers that have confirmed their participation in the Symposium
Papers can be assigned to sessions, where a session is a consecutive set of presentations or a set of posters. Each paper can be assigned a presentation duration, which is used when per-paper schedules are included in the conference program.
Sessions typically belong to a specific conference and track, but can also be assigned to multiple conferences and tracks.
The special and regular sessions are created with the appropriate session description. Each session can be chaired by any number of session chairs, although one or two is typical.
Sessions can be edited by either the conference or the publication chair, via Conference. Session chairs can go to Chairing and see a listing of the session they are chairing, including a link to the papers in the session.

In the meantime, if you have any questions or want to be at the scientific committee, please do not hesitate to contact us. cimee16@ul.edu.lb



The proceedings containing summaries of the plenary and technical sessions as well as full papers presented at the conference will be published by the CIMEE23 program committee as soon as possible.
Note to all participants:
CIMEE23 is a symposium that publishes manuscripts of good quality. The manuscripts sent to the symposium committee will move to the selection stage by the advisory and review committee then sent for publication in an international journal and editor such as Springer. For this we ask all participants to think carefully about:
submit an original research manuscript
write with a correct scientific language
take into account the instructions for the authors according to the journal.
We hope that you will enjoy the program and wish you a very fruitful symposium.
Looking forward to welcoming you in Lebanon!

The organizing committee,

Ahmad A. ElMoll
*CIMEE 2023 chairman*

## CONFERENCE SCOPE & TOPICS

The scientific scope will cover a wide range of fundamental and applied chemistry topics:

The 5th CIMEE will cover the following general topics:

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| T 1. MATERIALS & THE ENVIRONMENT<br>1.1. Nanomaterials, Nanostructures & Environment.<br>1.2. Nanomaterial-based biosensors for pollutants detection<br>1.3. Nanotechnology & Nanobiotechnology for Environmental Remediation<br>1.4. Carbon Nanotubes-Based Nanomaterials & Their Applications<br>1.5. Advanced Textile Materials for Composite Applications<br>T 2. ELECTROCHEMISTRY, BIOELECTROCHEMISTRY & ENVIRONMENT<br>2.1. Electrochemistry for the Environment<br>2.2. Electrochemical and environmental sensors, Biosensors technology<br>2.3. Organic electrochemistry & Bioelectrochemistry<br>2.4. Electrochemical nanosensors and their application.<br><br>T 3. ATMOSPHERIC CHEMISTRY & ENVIRONMENTAL POLLUTION<br>3.1. Aerosols, Air Pollution and Meteorology | T 4. STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY<br>4.1. Environmental chemistry, Analytical chemistry<br>4.2. Air quality, Pesticides & environmental monitoring,<br>4.3. Bioremediation & Phytoremediation of environmental Pollutants.<br>4.4. Remediation Technologies Applied in the Environment<br><br>T 5. AGRO GEOENVIRONMENT, AGROCHEMISTRY & BIOGEOCHEMISTRY<br>5.1. AgroGeoenvironment & Geomaterials<br>5.2. Biomaterials, Waste & biomass valorization<br>5.3. Atmospheric Chemistry, Geochemistry & Earth Materials<br>5.4. Agro-materials, & Environmental geochemistry.<br><br>T 6. CLIMATE CHANGE, MARINE & COASTAL ECOSYSTEM<br>6.1. Blue Carbon Ecosystems & Climate Change Mitigation |

C I M E E

INTERNATIONAL SYMPOSIUM ON MATERIALS, ELECTROCHEMISTRY & ENVIRONMENT

PROGRAM & ABSTRACT BOOK

| CIMEE23 Scientific Program | |
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| Day 1 - Thursday 21 September 2023<br>**(Morning session)** | |
| **Opening Session (Lebanon time (GMT+3))** | |
| 08h30 – 09h00 | Registration |
| 09h00 – 10h00 | Official Opening Ceremony: Lebanese National Anthem and LU anthem<br>Opening plenary session & welcome Speech from the Conference Chair, Dr. Ahmad ElMoll, Lebanese university, Lebanon<br>Opening address by Pr. The Kamel Ouari, Lab Head LEIMCR, University of F. Abbas, Algeria<br>Opening address by the Pr. Emmanuel Koudoumas, HMU, Herakion, Greece |
| 10h00 – 10h20 | Opening Keynote session, Advances in membrane and redox processes for water and wastewater treatment and reuse<br>Dr. Konstantinos V. Plakas, Centre for Research & Technology Hellas, CERTH, Thessaloniki, Greece |
| Keynote Session I: Biomaterials -Waste & biomass valorization, Chair/Co-chairs, Dr. M.M. Pazos Currás, Dr. A. ElMoll, Dr. K. Plakas | |
| 10h20 – 11h40 | KL 1: Potential lignin valorisation by fungal laccases<br>Pr. Susana Rodriguez-Couto, Dept. of Separation Science, Lappeenranta- LUT, Finland<br>KL 2, Biomass valorization technologies - Biochar for environmental and agricultural sustainability<br>Pr. M N V Prasad, University of Hyderabad, India<br>KL 3: Biocomposites and their Degradation<br>Pr. Dalila Hammiche, Faculty of Technology, University Mira- Bejaia, Algeria |
| 11h40 – 11h45 | Break Netwoking, Photography |
| **Afternoon Session** | |
| Oral Session I : Agro-Geoenvironment, Agrochemistry & Biogeochemistry, Chair/Co-Chairs: Pr. M. M. Pazos Curras, Dr. K. Plakas, Dr. A. ElMoll | |
| 11h45 - 12h45 | Sono-Fenton Depolymerization of Lignin into Value-Added Chemicals<br>Dr. Preety Kumari, Depart. of Chemical Engineering & National Center for Combustion Research & Development Indian Institute of Technology Madras, Chennai, India<br>Accelerated weathering influence on natural fibers and their composites<br>Dr. Roland. El Hage, PCH, C2MA, IMT Mines Ales, Ales, France<br>Flame retardancy of Miscanthus x giganteus particles by pre-irradiation grafting of a phosphorus-containing monomer<br>Dr. Clément Brendlé, PCH, C2MA, IMT Mines Ales, Ales, France<br>Geochemical elements of continental and marine surface sediments in southern Morocco: as an indicator of environmental and climate change. (Not presented)<br>Dr. Jawad El Hawari, Lab. Dynamics of Landscape, Risk and Heritage, Sultan Moulay Slimane University, Morocco |
| 12h45 – 13h30 | Light Lunch Break, Photography |
| Keynote Session II: Photocatalytic Materials for Environmental Applications, Chair/Co-Chairs: Dr. M. M. Pazos Dr. K. Plakas, Dr. A. ElMoll | |
| 13h30– 14h30 | KL 4 Photocatalytic Degradation of Plastic Waste: Recent progress and Future Perspectives,<br>Dr. Amra Bratovcic, University of Tuzla, Tuzla, Bosnia & Herzegovina<br>KL 5 Photocatalytic degradation of textile wastewater: efficiency, toxicity evaluation and reuse perspective,<br>Pr. Giusy Lofrano, University of Rome "Foro Italico", Italy<br>KL 6 Photocatalytic Materials for Environmental Remediation: Basic concepts & Current State Analysis (Part I)<br>Pr. Ridha Djellabi, Department of Chemical Engineering ETSEQ, Universitat Rovira i Virgili, Tarragona, Spain |
| 14h30 – 15h00 | Panel Discussion Pr. M. M. Pazos Curras, Pr. Dalila Hammiche, |
| Oral Session II : Structural, analytical & physical chemistry Chair/Co-Chairs, Dr. K. Plakas, Dr. A. ElMoll, Pr. K. Ouari | |
| 15h00 – 16h00 | Flat Plate Solar Selective Absorber Materials via Electrophoretic Deposition (EPD) Methods (Not presented)<br>Dr. Hiba Al Amouri, Institut de Chimie séparative de Marcoule- UMR5257, CEA/CNRS/ENSCM, 30207, Bagnols-sur-Cèze, France<br>Functional doped membranes with green and smart additives for wastewater remediation<br>Dr. Giulia Rando, Department of Chemical, Biological, Pharmaceutical and Environmental Sciences (ChiBioFarAm), University of Messina, Viale F. Stagno d'Alcontres, Messina, Italy<br>Eco-Friendly Antifouling and Fouling-Release Coatings for Blue-Growth Environmental Applications<br>Dr. Silvia Sfameni, Institute for the Study of Nanostructured Materials, ISMN-CNR URT Messina, Viale F. Stagno d'Alcontres 31, Vill. S. Agata, Messina, Italy.<br>Thiourea Formo-Phenolic Resins for Soft Metals Recovery (Au, Pd, Hg…) by Solid-Liquid Extraction<br>Dr. Claudine El Khoueiry, Institut de chimie séparative de Marcoule ICSM, Univesité de Montepellier, France |
| Keynote Session III Nanomaterials and catalysts for energy Production, Chair/Co-Chairs: Dr. A. ElMoll, Dr. R. Djellabi, Dr. K. Plakas | |

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| 16h0 – 16h40 | KL 7 Nanocatalysts for Hydrogen production: Recent and innovated Technologies<br>Pr. Hilal Demir Kivrak, Eskişehir Osmangazi University, Faculty of Engineering & Architectural Sciences, Eskişehir, Turkey<br>KL 8 Developments in the green hydrogen economy in the Netherlands<br>Dr.-Ing. Julio César Garcia-Navarro, Netherlands Organisation for Applied Scientific Research, TNO, Netherlands |
| Oral Session III Structural, analytical & physical chemistry Chair/Co-Chairs: Dr. R. Djellabi, Dr. K. Plakas, Dr. A. ElMoll | |
| 16h40 – 17h00 | $CO_2$ Sequestration and Utilization into value added products by efficient biocatalytic system (Not presented)<br>Dr. Sujata Negi, Depart. of Chemistry, Central University of Haryana, Depart of Environmental Science, Central University of Himachal Pradesh, India<br>Sedimentology and depositional environment of Jhil Member Limestone, Gaj Formation, Miocene, Pakistan<br>Dr. Sayed Haroon Ali, Department of Earth Sciences, University of Sargodha, Sargodha, Pakistan |
| 18h30 – 18h45 | Discussion- close day (1 Opening plenary session, opening keynote session, 3 Keynote sessions and 3 oral sessions) |

| **Day 2: Friday 22 September** | |
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| 08h30 – 09h00 | Registration |
| 09h00 – 09h20 | PL 2 Trends in water pollutant monitoring with smart devices,<br>Pr. Najla Fourati, CNAM, Paris, France |
| **Morning Sessions** | |
| Keynote Session IV: Sustainable corrosion inhibition and environmental applications, Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll, Dr. K. Plakas, | |
| 09h20 - 09h40 | KL 9 Green Corrosion Inhibitors: Towards developing non-toxic corrosion inhibitors from natural sources<br>Dr. ElMoll Ahmad, Faculty of public Health SIII, Faculty of Sciences, DSST, Lebanese university, Lebanon |
| Oral Session IV: Electrochemistry and the environmental Dr. N. Fourati, Dr. A. ElMoll, Pr. K. Ouari, Dr. K. Plakas | |
| 09h40 - 10h25 | Electrochemical behavior of iron salen complexes with linear bridges<br>Dr. Merzougui Moufida, Lab. of Electrochemistry, Molecular Engineering and Redox Catalysis, Faculty of Technology, Ferhat Abbas University, Setif, Algeria.<br>Greatly improved the cleavage of C-H bond of methane via Ni cluster supported on NiCu (100) surface.<br>Dr. Somia Benchikh, Lab. of Quantum Physics and Dynamical Systems, Chemistry Depart, Sciences Faculty, Ferhat ABBAS Setif-1 University, Algeria<br>Performance evaluation of newly synthetized derivatives as corrosion inhibitors for mild steel in 3.5 % NaCl solution (Not presented)<br>Dr. Karima Cherrak, L2ACME, Depart. of Chemistry, Faculty of Sciences, Mohammed First University, Morocco |
| 10h25 – 10h40 | Panel discussion - Break Netwoking, Photography |
| Keynote Session V : Water resources, AgroHydrology and Sustainable environment, Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll, Dr. K. Plakas, | |
| 10h40 – 11h40 | KL 10, Challenges in the implementation of circular economy (CE) in the water sector - recovery of water and raw materials.<br>Pr. Marzena Smol, Polish Academy of Sciences, Poland<br>KL 11, Enhancing Evapotranspiration Estimation in Remote Regions: Comparing Satellite-Based Techniques and Hydrological Modeling in a Tropical Monsoon River Basin<br>Dr. Ankur Sirvastava, Faculty of Science, University of Technology Sydney, Sydney, Australia<br>KL 12, Sustainable Water and Wastewater Status in the Gaza Strip: challenges and solutions<br>Dr. Mahmoud Shatat, Institute of Water and Environment- Al Azhar university Gaza, Palestine. |
| 11h40 – 13h15 | Light Lunch Break, Photography |
| **Afternoon Sessions** | |
| Keynote Session VI Materials and the Environment, Chair/Co-Chairs: Pr. N. Fourati, Dr. A. ElMoll, Pr. A. Bratovic, Dr. K. Plakas | |
| 13h15 – 14h35 | KL 13 Advances in the eco-design and synthesis of materials for the aquatic environment restoration,<br>Pr. Marta Pazos Currás, University of Vigo, Spain.<br>KL 14 Benign-by-design nanomaterials for Sustainable applications,<br>Pr. Rafael Luque, King Saud University, Riyadh, Saudi Arabia<br>KL 15 Smart green materials for waste water remediation (Not presented)<br>Pr. Ajay Kumar Mishra, Durban University of Technology, Dept. of Chemistry, South Africa, India<br>KL 16 Smart and innovative multifunctional materials: from design & synthesis to sustainable application<br>Dr. M. Rosaria Plutino, Institute for the Study of Nanostructured Materials, ISMN – CNR, Palermo, c/o Dep. ChiBioFarAm, Uiversity of Messina, Italy |
| Oral Session V: Structural, analytical & physical chemistry, Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll | |
| 14h35 – 15h20 | Assessment of the physiochemical potable water quality of Beirut and Mont-Lebanon, Lebanon (Not presented)<br>Dr. Fatima Abou Abbass, Faculty of Agriculture & veterinary medicine, Lebanese University, Beirut, Lebanon<br>Development of multifunctional Diatomite-Based absorbents for the removal of toxic metal ions from aqueous solutions |

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| | Dr. Oksana Dudarko, Chuiko Institute of Surface Chemistry of NAS of Ukraine, Ukraine – Depart. of Molecular Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden<br>The Effectiveness of Two Hydroponically Alfalfa (Medicago Sativa L.) as compared to Open Field System in Mount Lebanon (Not presented)<br>Dr. Carole Nachar, Faculty of Agronomy, Lebanese University, Beirut, Lebanon<br>Catalytic Degradation of Organic Dyes using Green-synthesized silver nanoparticles<br>Dr. Baraa U. Hijazi, Depart. of Chemistry, Faculty of Science, Beirut Arab University, Beirut, Lebanon |
| **Special session I:** Natural Resources management & Environmental Sustainability in Agriculture, Chair/Co-Chairs: Pr. N. Fourati, Dr. A. ElMoll | |
| 15h20 – 16h20 | Natural Resources management & Environmental Sustainability in Agriculture (Not presented)<br>Pr. Nadine Nassif, Dean of faculty of Agronomy, Lebanese University, Lebanon<br>Hydrogeochemical study of Zahrani watershed (Lebanon) and its vulnerability to pollution (Application of RISKE method)<br>Dr. Ahmad El Hajj, Faculty of Science, Fanar, Lebanese University, Lebanon |
| 16h20 – 16h30 | Break, Panel Discussions |
| Oral Sessio VI : Structural, analytical & physical chemistry, Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll | |
| 16h30 – 17h00 | An Approach for Energy Recovery from Closed Old Landfills in Algeria. (Not presented)<br>Dr. Ibrahim Rahmouni, Lab. of Applied Energetic Physics (LPEA), Depart. of Physics, Faculty of Matter Sciences, University of Batna 1, Algeria<br>Influence of molar ratio and synthesis conditions on adsorptive properties of NiFe-LDHs nanomaterials for organic dyes and radionuclides removal applications (Not presented)<br>Dr. Natalia Kobylinska, A.V. Dumansky Institute of Colloid and Water Chemistry, National Academy of Science of Ukraine, Kyiv, Ukraine |
| Keynote Session VII: Photocatalytic Materials for Environmental Applications, Chair/Co-Chairs: Dr. K. Plakas, Dr. A. ElMoll | |
| 17h00 – 17h25 | KL 28 Combination of photocatalysis with other emerging technologies for environmental applications<br>Pr. Ridha Djellabi, Department of Chemical Engineering ETSEQ, Universitat Rovira i Virgili, Tarragona, Spain |
| 17h25– 17h35 | Close day 2 |

| **Day 3: Saturday 23 September, Lebanon time (GMT+3)** | |
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| 08h30 – 09h00 | Registration |
| 09h00 – 09h20 | PL 3 Mössbauer and magnetic characterization of technogenic particles in topsoil - emission sources evidence<br>Pr. Tadeusz Szumiata, Kazimierz Pulaski University of Radom Poland |
| **Morning Sessions** | |
| Keynote Session VIII : Electrochemistry of Phytochemicals & Natural products, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, Dr. Ridha Djellabi | |
| 09h20 - 10h00 | KL 17 Imperative Role of Natural Product Chemistry in Cosmeceutical R&D - Phytocosmeceuticals BIO Ressources<br>Pr. Ilkay Erdogan Orhan, Dean, Depart. of Pharmacognosy, Faculty of Pharmacy, Gazi University, Ankara, Turkey KL 18: Engineering of Bacillus thuringiensis and its cry genes<br>Pr. Slim Tounsi, General Director at Centre of Biotechnology of Sfax, University of Sfax, Tunisia |
| 10h00 – 10h10 | Panel Discussion |
| Keynote Session IX Structural, analytical & physical chemistry, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, Dr. R. Djellabi | |
| 10h10 – 11h10 | KL 19 Urban green infrastructures towards sustainability and regulation of air quality<br>Pr. Hajri Haska. Fac. of Forestry Sciences, Agricultural Univ. of Tirana, Albania<br>KL 20 Effect of Environmental Pollutants on Bee Products.<br>Pr. Ulaş Acaraz, Dept. of Food Hygiene & Technology, Faculty of Veterinary Medicine, Afyon Kocatepe University, Turkey<br>KL 21 Study of radiation-catalytic and radiation-thermal catalytic activity of polymorphic forms of $Al_2O_3$ in the water decomposition process (Not presented)<br>Dr. Imanova Gunel, Institute of Radiation Problems, Ministry of Science & Education, Republic of Azerbaijan |
| 11h10 – 11h20 | Break - Netwoking |
| Oral Session VII : Electrochemistry and Environment, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll | |
| 11h:20 - 11:50 | Synthesis, performance and inhibitory efficacy of new Imidazole-Heterocycles for the chemical industry<br>Dr. Walid Daoudi, Laboratory of Molecular Chemistry, Materials and Environment (LCM2E), Department of chemistry, University Mohamed I, Nador, Morocco.<br>A New Iron Complex: Active Catalyst for Homogeneous Cyclohexene Epoxidation.<br>Dr. Souad Dekar, Laboratory of Electrochemistry, Molecular Engineering and Redox Catalysis, Faculty of Technology, Ferhat Abbas University, Setif 19137, Algeria. |

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| Keynote Session X : Nanotechnologies & Sustainable Nanomaterials for environmental Applications, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll | |
| 11h50 – 13h10 | KL 22, Novel nanotechnologies & Sustainable Nanomaterials for environmental Applications: Recent advances & future Perspectives<br>Pr. Zafar Said, Depart. of Sustainable and Renewable Energy Engineering (SREE), University of Sharjah, UAE<br>KL 23, Green nanotechnology: potential approach for clean & sustainable environment<br>Pr. Seema Garg, Amity Institute of Applied Sciences, Amity University, Noida, India<br>KL 24, Pure and doped TiO2 use to achieve germicidal action of nanocomposites<br>Pr. Mirela Suchea, CEMATEP, Hellenic Mediterranean University, Heraklion, Greece [2] NIR&D in Microtechnologies, Bucureşti, Romania (Not presented)<br>KL 25, Preparation and Application of Layered Double Hydroxide Composites Modified with Thiourea Derivatives in Environmental Applications (Not presented)<br>Dr. Esra Demirdogen, Faculty of Science, Çankırı Karatekin University, Turkey |
| 13h10 – 13h40 | Light Lunch Break, Photography |
| **Afternoon Sessions**<br>**Special session II** | |
| Special session II : Bioenergy, Bioresource Technology & Environmental Sustainability Chair/ Co-chairs: Pr. K. Ouari, Dr. R. Djellabi | |
| 13h40 – 16h00 | Hydrothermal Liquefaction of Biomass for Biofuels, Chemicals and Bio-products - From Fundamentals to Applications<br>Pr. Vinu Ravikrishnan, Indian Institute of Technology, Madras, India<br>Physical insight into ultrasound-assisted biodesulfurization (Not presented)<br>Pr. Vijay S. Moholkar, Head of Chemical Engineering, IIT Guwahati, India<br>Microalgae for wastewater treatment along with biomass valorization<br>Pr. Kaustubha Mohanty (FRSC), Head of Chemical Engineering, IIT Guwahati, India<br>Waste to Energy: An Investigation of Fuel Properties and Application with Health Risk Assessment<br>Dr. Chakma Sankar, Indian Institute of Science Education and Research, India<br>Hydrogen production from wastewater: Ecological and economical point of view,<br>Dr. Ahmad ElMoll, Faculty od Public Health, Faculty of Science, DSST, Lebanese university, Lebanon |
| Keynote Session XI : Structural, analytical & physical chemistry, Chair/ Co-chairs:Dr. A. ElMoll, Pr. K. Ouari | |
| 16h00 – 16h40 | KL 26, Biosurfactant from Serratia plymuthica as a green and effective solution for the recovery of metals from CRT waste.<br>Pr. Deepak Pant, Department of Environmental Sciences, Central University of Himachal Pradesh, India<br>KL 27, Environmental biotechnology trends in water resources conservation: microalgae based process<br>Dr. Jihen Elleuch, Lab, de Génie Enzymatique et Microbiologie, ENIS, Université de Sfax, Sfax, Tunisia |
| Oral Session VIII: Agro-Geoenvironment, Agrochemistry & Biogeochemistry, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, | |
| 16h40 – 17h10 | Agro-environmental sustainability: the potential role of Green Nanotechnology<br>Dr. Ahmad ElMoll, Faculty of Public Health, Faculty of Science, DSST, Lebanese University, Lebanon<br>Climate changes and riparian forests – a case study from Albania.<br>Pr. Hajri Haska, Faculty of Forest Sciences, Agricultural University of Tirana, Albania<br>Potential role on soil fertility of biochar obtained by date palm pruning residues at a farm level in United Arab Emirates (Not presented)<br>Dr. Nora Baldoni, Integrative Agriculture Depart, College of Agriculture and Veterinary Medicine, Al Ain, United Arab Emirates |
| 17h10 – 17h20 | Refreshments - Break Networking |
| Oral Session IX: Green Corrosion Inhibitors and Natural products, Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, | |
| 17h20 – 18h20 | Green synthesis of silver nanoparticles using pineapple peel extract (Ananas comosus) and study of their anti-corrosion properties<br>Dr. Bassam I. Zaarour, Depart. of Chemistry, Faculty of Science, Beirut Arab Universit, Beirut, Lebanon<br>Kiwifruit peel extract-mediated synthesis of silver nanoparticles and assessment of its corrosion inhibition efficiency on mild steel in acidic medium<br>Dr. Nahid M. Chehade, Depart. of Chemistry, Faculty of Science, Beirut Arab University, Debbieh, Lebanon<br>Corrosion inhibition of carbon steel in acidic solutions using Phaseolus vulgaris L. extract as a green inhibitor<br>Dr. Mohamad Kilo, Depart. of Chemistry, Faculty of Science, Beirut Arab University, Beirut, Lebanon |
| 18h20 – 17h30 | Panel Discussion |
| **Closing session and conclusion** | |

## WELCOME MESSAGE FROM THE ORGANIZING COMMITTEE CHAIRS

Dear Authors,

Boosted by the success of the last three editions CIMEE16, CIMEE18, CIMEE20, CIMEE22 and CIMEE23 of these symposia, the Lebanese university, European and north African partner universities have once again come together to create a forum where scientists from Middle East and abroad can define the future trends in chemistry and the best solutions to the environment. Globally, we are witnessing increased interest in many researchers' academics and scientists, which require looking at innovative environmental solutions from different perspectives.

Further to that success, the CIMEE23 Advisory and review committee is proud to organize the Fifth International Symposium on Materials, Electrochemistry and Environment. Contributions dealing with any discipline promoting research in Environment materials, electrochemical environment and environmental analytical chemistry are welcome.

I would like to welcome all the participants, and especially, to express the warmest gratitude to all the presenters for sharing their valuable experiences with all CIMEE23 participants. Many thanks go to Advisory and review committee co-chair for his outstanding efforts. My special thanks go to my good friends and reviewers, without their help this conference would not have taken place.

Authors of the most outstanding contributions, as selected by the CIMEE23 advisory and review committee, will be invited to publish their work as a research article (maximum length of 6 pages), in a Special Issue of the collaborating journal.

On behalf of our dynamic editorial staff and active scientific committee, we warmly invite you to join us during this edition.

*Organizing committee Chair*


**SEPTEMBER 21 - 23, 2023 | BEIRUT, LEBANON**

Symposium Partners

# COMMITTEES

## COMMITTEES

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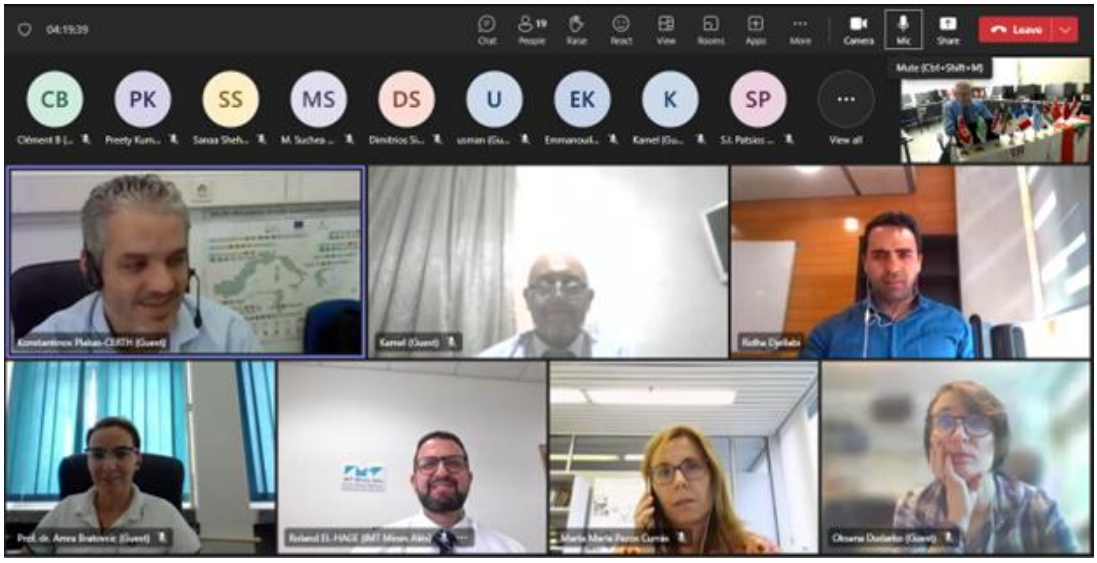
# CIMEE23 OFICIAL OPENING CEREMONY



The first day of the conference featured an Opening Ceremony. This session welcomed all participants to the Fifth edition of the International Symposium and officially started the 3-day program.

The Fifth international Symposium was officially opened in the large conference hall of the CNF; around 80 participants were present. The program began with the Lebanon's national anthem & Lebanese University.

## Opening Ceremony, - Thursday 21 September 2023



## Opening Ceremony

### Welcome message from the Conference Chair, CIMEE23

Assoc. Prof. Dr. ElMoll Ahmad, Faculty of Public Health, SIII
Faculty of Sciences, SIII
DSST, Lebanese University, Lebanon

Dear Colleagues, Dear friends, Distinguished Guest Speakers,

The CIMEE group and Lebanese university are pleased to be organize the fifth Edition of the International Symposium, CIMEE'23, which will be held in Porto (Portugal) from 21 to 23 September 2023.

This 5th International Conference, CIMEE'23 will bring together researchers and scientists involved in diverse aspects of green chemistry, including environmental analytical chemistry, their applications in environment as well as the latest developments concerning Materials, electrochemistry and applied science. This conference will set the stage for the dissemination and exchange of new developments in various hot fields within chemistry/Environmental chemistry, and provide opportunities to researchers for inspiration, collaboration and networking in academia and industry.
The CIMEE is organised annually on behalf of the Association of multiple universities from Europe, Middel East and North Africa on the Chemistry and the Environment. It traditionally comprises a broad range of topics within the field of environmental chemistry, and interdisciplinary presentations are very welcome. The CIMEE conference always attracts high quality science presentations and keynote talks from internationally renowned researchers working in environmental chemistry and related fields.
Under the motto "Green Chemistry and innovative Technology Towards a more sustainable environment ", the 5th edition (CIMEE'23) will continue the tradition of previous meetings, hoping to contribute for a lasting sustainability of our planet's environment. It will provide a wide forum for the exchange of ideas on recent advances in research and development in environmental chemistry and advanced technology, for people from academia, research and industry.
We are looking forward to meeting you at CIMEE'23 conference and hope this will be a fruitful and pleasant scientific event.
Yours faithfully,
Assoc. Prof. ElMoll Ahmad
CIMEE23 Conference Director

# Opening Ceremony

## Welcome message from the Director of LEIMCR, Algeria

Université Ferhat ABBAS Sétif 1
Prof. Kamel, OUARI, Laboratoire d'Electrochimie, d'Ingénierie Moléculaire et de Catalyse Rédox (LEIMCR, UFA, Sétif 1), Algeria

Prof. Kamel Ouari, research interests: Materials Chemistry, Electrochemistry, Catalysis

Currently works at the Department of Processes Engineering, Faculty of Technology, Ferhat Abbas University of Setif1. He does research in Materials Chemistry, Electrochemistry and Catalysis.

Dear Colleagues, Dear friends, Distinguished Guest Speakers,

Good morning and I hope you are doing well. Thank you to each and every one of you for being here with us today. It is a great pleasure for me to participate in opening ceremony CIME23. I would like to welcome the participants who came here to exchange experience and work together a few days on this exciting field. Specific thanks go to Prof. Ahmad El Moll for his effort in organization of this event. Besides, I wish to extend the greetings of the Board;

Electrochemistry is a powerful tool for detecting several pollutants in the environment. Significant advances in electrochemical engineering technology over the past three decades have promoted the development of alternative methods to mitigate and prevent the generation of environmentally harmful pollutants. The feasibility of zero pollutant emissions during production processes was considered more than 30 years ago. In practice, this strategy is difficult to implement and technologies to minimize and convert pollutants into environmentally harmless by-products are a more realistic and feasible option. Several advanced electrochemical technologies can be considered. These technologies include wastewater treatment and metal ion recovery as well as direct and indirect methods of oxidation of organic compounds. Electrochemical technologies have also contributed to methodologies of the elimination of harmful gases such as carbon dioxide, nitrogen oxides and sulfur dioxide. Electrochemical methods are also useful in treating soils contaminated with metals and organic matter.

Moreover, electrochemical sensors play a significant role in detecting chemical ions, molecules, and pathogens in water and other applications. These sensors are sensitive, portable, fast, inexpensive, and suitable for online and in-situ measurements compared to other methods. They can provide the detection for any compound that can undergo certain transformations within a potential window. It enables applications in multiple ion detection, mainly since these sensors are primarily non-specific. For example, electrochemical sensors for the detection of water contaminants, i.e., pesticides, nitrate, nitrite, phosphorus, water hardeners, disinfectant, and other emergent contaminants.

Before ending the welcome speech, I would like to emphasize that the conferences are not only important for our researchers but also to improve the ranking of the university which is based on international publications and the number of highly cited articles as well as the global reputation and visibility of research. Indeed, this type of event mainly improves the visibility of Mediterranean universities and strengthens their position at all levels.

I hope you enjoy this day and the next two days of debate and networking. Thank you for your participation, so welcome and enjoy the meeting.

# Opening Ceremony

## Welcome message from the Prof. Emmanouel Koudoumas, HMU, Greece

Department of Electrical & Computer Engineering
Hellenic Mediterranean University

Dear Colleagues, Dear friends, Distinguished Guest Speakers,

The progress of the technology today requires a new generation of materials and devices, exhibiting the same or even superior performance, lower cost, environmental friendliness and better physical properties than that currently used. In that respect, the activities of the Smart Functional Materials group, of the Center of Materials Technology and Photonics of the Hellenic Mediterranean University are focused on the exploitation of advanced coatings, nanostructures, suspensions and nanocomposites suitable for applications like solar control coatings, electromagnetic shielding photocatalysis, antifouling, Li ion batteries, nanodielectrics, food packaging etc. In particular, the current scientific achievements of the group concern:
(a) The development of water or alcohol based formulations of conductive paints, containing carbon nanotubes, graphite, carbon black, Fe3O4, Fe ore, and PEDOT:PSS in various ratios and combinations, specially designed for electromagnetic interference shielding (EMI) in the GHz frequency range
(b) The development of composite materials based on Graphene Nanoplatelets (GNPs) and Multiwall Carbon Nanotubes (CNTs) embedded in Polypropylene (PP) for Electromagnetic interference (EMI) in the GHz frequency range
(c) The development of new composite materials based on HDPE and Cu:TiO2 nanoparticles, exhibiting antifouling properties for aquaculture nets
(d) The use of simple, low cost and environmental friendly spray techniques for the development of WO3 nanostructured thin films exhibiting good electrochromic activity and reasonably good durability.
(e) The development of composite food packaging based on PLA and encapsulated natural extracts, exhibiting antimicrobial performance.

**Short bio**

Prof. Emmanuel Koudoumas is a Professor in the Department of Electrical and Computer Engineering at the Hellenic Mediterranean University, Greece. His research efforts are concentrated in the use of simple, low cost and environmental friendly techniques for the growth of thin films, nanostructure layers, nanomaterials, nanocomposites and suspensions, based on pure or doped metal oxides, metals or carbon allotropes, exhibiting properties suitable for control light transmission, photo-catalytic/antifouling/antibacterial action, self-cleaning windows, Li ion batteries, electromagnetic shielding, nanodielectrics, food packaging etc. He has 140 publications in peer review journal, with 3.200 citations and an h-index of 33, while he has been involved in a large number of funded projects as coordinator or member of the research team.

# Day 1- Thursday 22 September 2022

## Opening Plenary Session

Opening plenary session CIMEE'23 conference

To our distinguished guests, ladies and gentlemen – A very Warm Welcome!

On behalf of the Chairman of the Technical Program Committee and on my own behalf, I welcome you to the Fifth International Symposium, CIMEE23.

Today there is greater awareness of all environmental problems. Everywhere on the planet, the consequences of climate change are visible with extreme weather conditions such as drought, heat waves, heavy rain and floods, especially in Mediterranean region. The scientific research which leads to a better understanding and knowledge of environmental issues is vital if we are to not only to protect our fragile environment, but also to ensure it is safe and healthy for present and future generations. The interest of the international scientific community is strong. The CIMEE23 Conference, organized in this context, has attracted 100 participants from 20 countries. We will hear more than 70 oral presentations, and have the opportunity to see 2 special sessions with the possibility to publish the best papers presented at the conference in partner journals. A wide choice of subjects was made: new materials/nanomaterials, electrochemistry, environmental monitoring and environmental analysis techniques. I am sure that the selected topics will provide you with a wealth of information and numerous opportunities for discussion The challenges made by the CIMEE'23 Conference are significant, but I am confident that you will succeed in your objectives. I wish you a very pleasant participation and a productive and successful meeting.

Dear colleagues, for this particular Opening Session of the CIMEE'23 Conference, there are two clear benefits that I would like to draw your attention to — benefits that go well beyond the primary purpose of the Conference which is to exchange the latest, up-to-date information on a range of new materials, electrochemistry and analytical techniques to help solve problems across all environmental sectors

Firstly, this Conference substantially builds, reinforces, enhances, and develops, most of the important areas of common interest and collaborative action that all universities and researchers in MENA region and CIMEE group currently share, across the health of environment and the planet

Such areas include, for example:

1: Reducing Greenhouse Gas Emissions that contribute to climate change

2. Water Management and water resources protection

3. Waste Management using a Green Chemistry Approach

4. Energy production and consumption, contributing to a cleaner and low carbon environment.

Among the solutions:

a) Design, synthesis, and application of novel materials in energy conservation & pollution control;

b) New chemical technologies in the conversion and transformation of energy & pollutants;

c) Reusing waste in the circular economy (Wastewater and plastic pollution) Reuse and recycle resources – can reduce carbon footprint and improve energy efficiency.

d) Biomass and biofuels as a renewable source of energy

Then secondly – the second benefit I would draw your attention to, and of even greater significance than the first, but following from it, relates to the still vast global numbers, the large population groups in the world, suffering from Waste pollution such as Wastewater pollution and Plastics waste pollution

These are just a few examples of how interagency collaboration between CIMEE group, Lebanese university and all partners -working together in support of MENA region

And we depend and draw upon your expertise to help us develop and channel latest techniques such as new materials (for the environment or energy) and advanced analytical methods, to benefit the health of environment.

So we in CIMEE group-Lebanese university are delighted to be participating in this International Conference with you — the experts — along with our colleagues in three continents Asia, Africa and Europe.

We are convinced that, looking at all the excellent preparatory work that has gone into the CIMEE'23 Conference, and looking at both the agenda and the impressive expertise gathered here, this International Conference will surely:

1. result in an exciting exchange of information on current developments and applications of novels materials, electrochemistry methods and analytical chemistry techniques,
2. explore potential opportunities for applying the recent materials and advanced analytical techniques in environmental monitoring.

And related to these immediate objectives are the further benefits I've outlined, to both CIMEE/partners strengthened collaboration and ultimately to many universities worldwide.

I congratulate the organizing committee on the organization of this splendid International Conference.

And I wish you all — us all — the very best for a most successful meeting.

Assoc. Prof. ElMoll Ahmad

CIMEE23 Conference Director

Yours faithfully,

On behalf of Organizing and Program Committees

# Day 1- Thursday 22 September 2022

## Opening keynote Session

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

Assoc. Researcher, Dr. Konstantinos Plakas,
Centre for Research and Technology - Hellas
CERTH, Thessaloniki, Greece

**Konstantinos V. Plakas**, Centre for Research and Technology, Hellas (CERTH), Thessaloniki, Greece

### OPENING KEYNOTE LECTURE

Description of the session

Advanced Electrochemical Processes for Water Treatment and a Cleaner Environment, CERTH
The field of electrochemistry has emerged as a promising solution to some of the challenges facing our planet, including the need for sustainable energy sources and the mitigation of environmental pollution. Electrochemical materials have been widely studied for their potential applications in wastewater treatment, where they offer versatile capabilities for the removal of organic and inorganic pollutants. This keynote lecture will be focuses on the development of simple, efficient, and cost-effective processes based on membrane technology and redox reactions. As well as on pressure-controlled membrane processes such as reverse osmosis, nanofiltration, ultrafiltration, and microfiltration

We will see in this presentation a big part on the emerging advanced oxidation processes (AOP), which are considered promising alternative methods for efficient removal of recalcitrant, toxic, and non-biodegradable organic pollutants from water.

**Opening Keynote, KL1**

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# Advances in membrane and redox processes for water and wastewater treatment and reuse

Konstantinos V. Plakas

*Centre for Research and Technology - Hellas CERTH, Thessaloniki, Greece*

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*Thematic Area: MATERIALS & THE ENVIRONMENT*

## Abstract

The increasing need for effective methods to increase water availability provides strong incentives for developing new technologies and improving the performance of existing technologies toward a number of key goals identified under the United Nations Sustainable Development Goal 6, such as improving water quality, wastewater treatment and safe reuse, increasing water use efficiency, implementing integrated water resources management, and protecting and restoring water-related ecosystems. Therefore, research and development on various aspects of water and wastewater treatment has increased tremendously in recent years. Special attention is currently being paid to the development of simple, efficient, and cost-effective processes based on membrane technology and redox reactions. In this keynote lecture, the latest developments in pressure-controlled membrane processes such as reverse osmosis, nanofiltration, ultrafiltration, and microfiltration will be discussed along with the emerging advanced oxidation processes (AOP), which are considered promising alternative methods for efficient removal of recalcitrant, toxic, and non-biodegradable organic pollutants from water. Experience and lessons learned from relevant CERTH R&D efforts will be shared along with recommendations for future research priorities. These include (a) development of new electrode/membrane/catalyst materials characterized by long-term stability, corrosion tolerance, and lower material cost, (b) optimal cell/reactor design (morphology, type, electrode/membrane arrangement, spacer configuration, etc.), (c) development of comprehensive and reliable methods for determining the quality of electrodes and membranes.), c) the development of comprehensive and robust models for process optimization, d) the design of autonomous systems powered by renewable energy (estimation of electrical energy requirements), e) the optimization of operation and maintenance procedures (maintenance related to electrode/membrane/spacer cleaning), (f) pilot-scale demonstrations that provide information on scalability and treatment costs and allow long-term studies of important phenomena such as fouling, scaling, and degradation of electrodes and ion-exchange membranes; and (g) comprehensive environmental assessments such as life-cycle analyzes and environmental impact assessments. Finally, the development of integrated processes that successfully address issues such as (a) pretreatment of feedwater to minimize membrane fouling potential, (b) treatment/safe disposal of concentrates, and (c) complete retention of organic contaminants to protect human health should be pursued.

**Keywords:** water pollution, emerging organic contaminants, water reuse, zero liquid discharge, advanced water treatment, membrane processes, advanced oxidation

# KEYNOTE SESSION 1:

Biomaterials -Waste & biomass valorization,

Chair/Co-chairs, Dr. M.M. Pazos Currás, Dr. A. ElMoll, Dr. K. Plakas

**Session 2, Biomaterials -Waste & biomass valorization,**
**Keynote Session, KL1**

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# Potential lignin valorisation by fungal laccases

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*Thematic Area: Environmental Biotechnology, Bioeconomy*

## Abstract

Lignin has the potential to become a future aromatic raw material for the industry but is largely underexploited due to lack of (information on) industrial availability, sustainable applications, and environmental footprint. Additionally, lignin valorisation is essential for the economic and sustainability of lignocellulosic-based biorefineries. Moreover, it will contribute to the development of Green Chemistry. However, currently, only 5%r of lignin is valorised into products such as lignin-based polymers, surfactants, 3D printing materials or fine chemicals [1] and the rest (i.e., 95%) is converted into energy through burning. This is mainly related to its highly recalcitrant nature. In this sense, white-rot fungi are the only microorganisms able to decompose lignin so far [2]. This ability is related to the secretion of non-specific extracellular enzymatic complexes during their secondary metabolism [3]. These enzymatic complexes are mainly composed of peroxidases and laccases. The latter has been the subject of numerous research in the last decades after the discovery that their broad substrate range can be even extended in the presence of redox mediators [4]. In addition, they only need environmental oxygen to exert their catalytic action instead of the hydrogen peroxide used by peroxidases. Nevertheless, despite the appalling properties of laccase enzymes, there are concerns regarding the economic viability of laccase-based lignin valorisation. Thus, more research in this area is still needed.

**Keywords**: biorefinery, laccase, lignin, valorisation, white-rot fungus

**Acknowledgements**: The authors thank Mikkeli University Consortium (MUC) for the funding support for the contract of Dr. O. Pinar.

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[2] Kirk TK, Fenn P. (1982); Cambridge University Press, Cambridge, pp. 67-90.
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**Session 2, Biomaterials -Waste & biomass valorization,**
**Keynote Session, KL2**

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# Biomass valorization technologies - Biochar for environmental and agricultural sustainability

Prasad, M. N.V.

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*Biomaterials, Waste and biomass valorization*

## Abstract

The product of biological activity can be termed as "Biomass" in a broader sense. If this is from plants, it is called "Phytomass", if this is from dead it is called "necromass". Biochar is obtained from the sumtotal of biomass. It is defined as carbonized biomass obtained from sustainable sources and sequestered in soils to sustainably enhance the agricultural and environmental value (International Biochar Initiative). However, biochar is often used synonymous with charcoal, but also mixed with: black carbon, pyrogenic carbon, activated carbon, soot, torrefied biomass, hydrochar, (HTC Hydrothermal carbonization) coal, wet charcoal, ash. In this presentation, the relevance biochar to combat climate change crisis is dealt with reference to contemporary issues viz., Anthropocene, Carbon Neutrality, Circular Economy, Clean Energy Transition, Decarbonisation and Environmental Footprint. Biomass pyrolysis for CO2 removal from the atmosphere. Biomass captures CO2 from the atmosphere during growth. Carbon is stored in phytomass while O2 is released into atmosphere. A large amount of C can be captured in pyrolysis in gas, liquid and solid phase. The energy produced is climate neutral and the solid (biochar) allows for carbon capture and storage, thus facilitate net climate positive process. Bamboo sequesters carbon at high rates hence well known for its green credentials [1,2].

**Keywords**: Bamboo forest, biomass forests, Changes in agroecosystems, Changes in Ecohydrology, Changes in Socioeconomics

**References**:

[1] Majeti Narasimha Vara Prasad and Marzena Smol (eds) 2023 Sustainable and Circular Management of Resources and Waste Towards a Green Deal. Elsevier. 443 pages

[2] Majeti Narasimha Vara Prasad Ed (2023) Bioremediation and Bioeconomy: A Circular Economy Approach. 2e Elsevier (in press)

**Session 2, Biomaterials -Waste & biomass valorization,**
**Keynote Session, KL3**

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# Biocomposites and their Degradation

Dalila Hammiche[1]

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*Thematic Area: Materials & the environment*

## Abstract

Biocomposites are essentially composite materials that are made from natural fiber and petroleum-derived no biodegradable polymers or biodegradable polymers. Biocomposites are very precious materials owing to their environmental benefits over their homologs. Eco-friendly bio-composites would be the materials for the near future not only as a solution to the growing environmental threat but also as a solution to alleviating the uncertainty of the petroleum supply but mainly to their advantages in terms of biodegradable materials. Plastics can be recovered by degrading them once their purpose is fulfilled and after use, without causing an increase in atmospheric $CO_2$ content. Biocomposites waste, which are discarded, will turn into biocomposites waste and will be naturally broken down by the air, moisture, climate, and soil, disintegrating into the surrounding land.

**Keywords**: composites, end life, degradation

**References**:

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# ORAL SESSION 1:

Agro-Geoenvironment, Agrochemistry & Biogeochemistry

Chairs: A. ElMoll, K. Plakas

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# Sono-Fenton Depolymerization of Lignin into Value-Added Chemicals s

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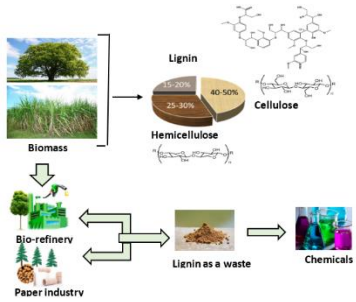
*Thematic Area: Agro Geoenviroment, Agrochemistry & Biogeochemistry*

## Abstract

The global demand for aromatic compounds is increasing because of their applications in pharmaceuticals, healthcare, paints and dyeing industry. Lignin, which is a major component of lignocellulosic biomass, is considered as a valuable source of phenolic and high value aromatic compounds. It is also the main by-product of paper-pulp and bio-ethanol industry [1]. Sonocatalytic depolymerization of lignin is considered as a non-conventional, benign and green method to produce value added chemicals from lignin [2]. In this work, sonocatalytic depolymerization of alkali lignin, in presence of alkaline medium and Fenton reagent is shown to exhibit better conversion than the sonolysis process, especially in terms of molecular weight reduction and selectivity of products. The sonochemical reaction was performed under fixed ultrasound frequency of 20 kHz using a probe-type sonicator, and the effects of operating conditions like time, lignin concentration, and ultrasound power were carried out to maximize the conversion of lignin and yield of phenolic compounds. Gas chromatograph/mass spectrometry (GC/MS) was used to identify the major phenolic compounds, which were Phenol, Guaiacol, Vanilline, Acetovanilline and Vanillic acid. The molecular weight distribution of lignin was analyzed by gel permeation chromatography (GPC), which exhibited a reduction in number average and weight average molecular weight of lignin after the sonocatalytic depolymerization reaction. The liquid yield is 72.05 % at the optimum operating condition of Sono-Fenton reaction. Kinetics of molecular weight reduction, and the mechanism of action of the active species in aiding the efficient degradation of lignin to value added chemicals will be discussed during the presentation.




**Keywords**: Depolymerization, Lignocellulosic biomass, Lignin, Sonocatalysis, Molecular weight distribution, Phenols.

**Acknowledgements**: **Acknowledgements**: The National Center for Combustion Research & Development is sponsored by the Department of Science and Technology, India.

**References**:

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# Accelerated weathering influence on natural fibers and their composites

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*Thematic Area: Biomaterials, waste, and biomass valorization*

## Abstract

Renewable lignocellulosic fibers are used more and more in the preparation of eco-friendly materials. Among the existing natural resources, the use of a sterile and non-invasive crop namely miscanthus x giganteus (MxG) [1] is of great interest and could be used in PP polymeric matrix as a green material design perspective. Hence, the present work aims to investigate the consequence of the chemical composition on the color modification of MxG in comparison to flax fibers and their incorporation in a commercial stabilized PP-based blue matrix using an accelerated artificial UV weathering up to 20 weeks. Results using a spectrophotometer show a lightening effect for native and extractive-free flax and darkening for native and extractive-free miscanthus. This behavior could be related to fibers cracking caused by the elimination of degradation products as confirmed by SEM observations. The impact on color perception is also related to the lignin content which is much important for miscanthus (23 wt%) compared to flax (9 wt%). Indeed, lignin is subjected to photocleavage and its transformation to colored chromophore groups (e.g. quinoids) or uncolored groups (e.g. quinoids transformation into carboxylic acid) [2] as confirmed by the ATR-FTIR analysis. Delignified fibers yellowing is related to residual lignin and holocelluloses photochemical degradation. Native and extractive-free PP composites show color enlightenment and disappearance of superficial black spots. These dark spots present before weathering are less important for miscanthus and seem to be caused by a higher thermal degradation of flax during the transformation process. This is explained by the better thermal stability of the miscanthus fibers as confirmed by TGA analysis which led to better color stability than flax. Delignified miscanthus and flax fibers composites show better color stability compared to the pure PP-based stabilized matrix.

**Keywords**: Natural fibers, biocomposites, UV weathering, automotive sector

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# Flame retardancy of *Miscanthus x giganteus* particles by pre-irradiation grafting of a phosphorus-containing monomer

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*Thematic Area: Biomaterials, wastes and biomass valorization*

## Abstract

Lignocellulosic substrates are gradually gaining importance in the conception of eco-friendly materials. MISCANTHUS X GIGANTEUS, which first attracted attention for energy production, looks promising in many ways. The low constraints associated with its cultivation as well as its productivity motivate its use in various domains (e.g. composites, particle boards, agro-concretes, etc.) [1]. However, as for many biomasses, it suffers from major drawbacks such as its flammability. For some applications, it is mandatory to remedy this issue. In this respect, radiation-induced grafting represents an interesting method compared to chemical or enzymatic methods. This technique is based on the use of ionizing radiation (gamma or e-beam), which generates radicals on the material, allowing the graft-copolymerization of functional monomers [2]. Two methodologies of radiation-induced grafting may be used: pre-irradiation and mutual irradiation. Numerous factors condition the success of grafting reactions. In particular, the structure and the composition of the substrate influence the nature of the active species generated, and therefore, the feasibility of the grafting reaction, raising the need to find solutions. This work aimed to impart flame retardancy to MISCANTHUS X GIGANTEUS particles by grafting a phosphorous flame-retardant molecule using the pre-irradiation method. Electronic Paramagnetic Resonance (EPR) is used to better understand the parameters influencing the grafting, and the flammability of treated Miscanthus is evaluated using Pyrolysis Combustion Flow Calorimeter (PCFC).

**Keywords**: Miscanthus x giganteus, Lignocellulosic substrates, Radiation-induced grafting, Flame retardancy

**References**:

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# Geochemical elements of continental and marine surface sediments in southern Morocco: as an indicator of environmental and climate change

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**(Not Presented)**

*Thematic Area: Climate Change, Marine & Coastal ecosystem*

## Abstract

Like other regions of Morocco, southern Morocco is presently subject to severe drought, desertification and socio-economic stress. Studies on climate change, landscape and vegetation have mainly focused on the northern regions of the country. In contrast, the climate and environmental history in the south of the country is largely unknown. In the case of our study, we have chosen the characterization of southern Morocco based on geochemical parameters (major and trace elements). Continental and marine samples are collected along the south of Morocco. The concentrations of chemical elements are obtained by X-ray fluorescence scanning (XRF) in order to define the effects of climate change and rainfall on the local environment and natural resources. The integration of the different results allowed us to reconstruct climate, ocean and environmental changes. That has enabled us to provide data for land-ocean correlations.

**Keywords**: South of Morocco, sediments, geochemical elements, spatial analysis, terrigenous input.

## KEYNOTE SESSION 2:

Photocatalytic Materials for Environmental Applications

Chairs: A. ElMoll, K. Plakas

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# Photocatalytic Degradation of Plastic Waste: Recent progress and Future Perspectives

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*Thematic Area: Photocatalytic Materials for Environmental Applications*

## Abstract

Microplastics are persistent anthropogenic pollutants that have become a global concern owing to their widespread existence and unfamiliar threats to the environment and living organisms.
Conventional technologies are not able to fully decompose and mineralize plastic waste and therefore there is a need to develop a green, innovative, and sustainable photocatalytic method that can destroy them with much less energy and chemical consumption. In photocatalysis are used various nanomaterials based on semiconductors with the wide energy band gap such as TiO2 and ZnO for the treatment of plastic contaminants into eco-friendly compounds. In this paper, the removal of plastic fragments by photocatalytic reactions using new developed photocatalytic composites and the mechanism of photocatalytic degradation of microplastics are systematically investigated. In this degradation processes the sunlight or an artificial light source is used to activate the photocatalyst in the presence of oxygen.

**Keywords:** plastic waste, microplastics, photocatalytic method, degradation, semiconductors, heterogeneous photocatalysts.

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# Photocatalytic degradation of textile wastewater: efficiency, toxicity evaluation and reuse perspective

Giusy Lofrano[1], Alice Cardito[2], Olga Sacco[2], Luisa Albarano[3], Maurizio Carotenuto[2], Vincenzo Vaiano[4], Federica Valeriani[1], Giovanni Libralato[3], Marco Guida[3],Vincenzo Romano Spica[1]

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*Thematic Area: Nanomaterials and the Environment*

## Abstract

Textile wastewaters (TW) represent a serious environmental and health concern when they are discharged without adequate treatment [1]. The presence of dyes in water can hinder the photosynthetic activity of aquatic plant, significantly affecting the aquatic life and determining significant risk to the food chain. Conventional treatment plants including physico-chemical, coagulation and membrane filtration do not allow a complete degradation of contaminants contained in such wastewater. The application of photocatalytic processes has gained a growing interest in last twenty years [2]. Figure 1 reports the number of papers selected by sciencedirect.com by using "photocatalytic degradation" and "textile wastewaters" as key words. This paper reviews the scientific literature published in the field, analyzing the potential impact of the effluents and the reuse perspective and presenting case studies.

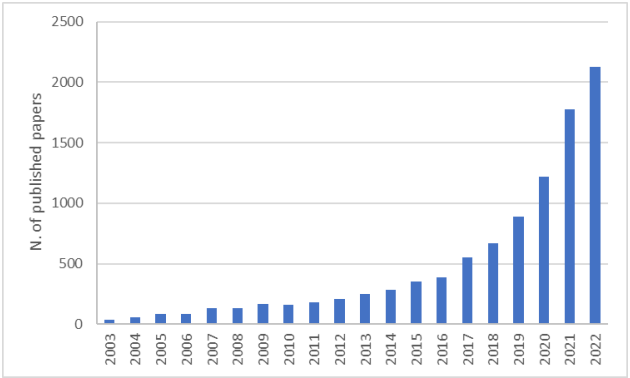


Figure 1. Number of papers published from 2003 to 2022 according to sciencedirect.com

**Keywords**: Photocatalysis, Textile wastewater, Toxicity

**References**:

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# Photocatalytic Materials for Environmental Remediation: Basic concepts & Current State Analysis

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*Thematic Area: Environmental Remediation*

## Abstract

Since the discovery of Honda and Fujishima in 1972, photocatalysis has passed a long and intensive research path up to date. Most of efforts have being devoted to understand the various phenomena occurring in different photocatalytic systems from the fundamental and scientific point of view. However, the potential of photocatalysis towards business, based on solving real contemporary environmental issues at large scale was rarely addressed [1, 2]. This talk aims to discuss the photocatalytic technology from fundamental basics to advanced research [3]. Technological issues that face the application of photocatalysis at large scale will be addressed and explained to narrow the gap between the lab scale and large-scale application. A SWOT analysis will be discussed to assess whether its main strengths can enable it to seize relevant opportunities for large-scale investment and commercialization of photocatalytic solutions, despite its weaknesses and external threats.

**Keywords**: Photocatalytic technology, Radical oxidation, Photocatalytic materials, Environmental remediation.

**Acknowledgements**: We are thankful for the support from Grant PID2021-123665OB-I00 and TED2021-129343B-I00 funded by MCIN/AEI/ 10.13039/501100011033 and, as appropriate, by "ERDF A way of making Europe", by the "European Union" or by the "European Union Next Generation EU/PRTR". We acknowledge also Maria Zambrano Grants-2021URV-MZ-15.

**References**: The text can contain citations [1-4]. Examples of the format to be used for citations are given below:

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# ORAL SESSION 2

Structural, analytical & physical chemistry

Chairs: Chair/Co-Chairs, Dr. K. Plakas, Dr. A. ElMoll, Pr. K. Ouari

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# Flat Plate Solar Selective Absorber Materials via ElectrophoreticDeposition (EPD) Methods

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**(Not presented)**

*Thematic Area: Materials & the Environment, Nanomaterials, Nanostructures & Environment*

## Abstract

This project aims to develop efficient and cost-effective flat plate solar selective absorber materials using Electrophoretic Deposition (EPD) methods. Solar selective absorbers play a crucial role in solar thermal systems by selectively absorbing sunlight while minimizing heat loss through radiation. EPD offers a versatile and scalable technique for depositing nanoparticles onto flat surfaces, enabling the creation of tailored optical coatings [1,2,3].
The research involves the synthesis and characterization of nanoparticle-based coatings to optimize their optical properties, such as absorptivity and emittance. Among the viable solar- selective coatings, iron oxide ($Fe_3O_4$) has demonstrated promising properties. A tandemabsorber, consisting of a $Fe_3O_4$ thin film deposited on a highly infrared (IR) reflecting metallicsubstrate, is produced through electrophoretic deposition (EPD). Furthermore, the project will focus on optimizing the EPD process parameters to ensure uniform and durable coatings on flatplate surfaces. The influence of deposition time, voltage, and electrolyte concentration on coating thickness and quality will be thoroughly examined to achieve reproducible and reliableresults.

**Keywords:** Electrophoretic Deposition, Iron Oxide nanoparticles, Selective Solar Absorbers.

**Acknowledgements**:
The authors would like to thank the University of Montpellier and the Lebanese National Council for Scientific Research (CNRS-L) for the co-joint funding of the project and the attribution of PhD's fellowship.

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# Functional doped membranes with green and smart additives for wastewater remediation

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*Thematic Area: Materials & the Environment*

## Abstract

Environmental contamination caused by manmade activity is becoming a severe problem, therefore one of the greatest challenges of the twenty-first century is to develop new eco-friendly, sustainable, and economically sound methods to clean up contaminants in the environment. Nanotechnologies and new performing nanomaterials have the potential to develop sustainable, advanced, and innovative products/techniques for environmental remediation due to their unique properties such as high surface area (surface/volume ratio), catalytic capacity, reactivity, and ease of functionalization to chemically modulate their properties [1]. Membrane-based approaches for filtration and remediation of polluted water are being used in this context to remove various contaminants and/or desalinate water. Membranes may be developed using a rational design from various functional blended polymers doped with suitable cross-linkers, stimuli-responsive systems, or nanofillers to increase the performance of such filtering systems [2].

The topic of this presentation focuses on the design and development of smart and sustainable polymeric blends that are employed to prepare various membranes using different approaches. Furthermore, functional nanofillers and additives were utilized as dopant agents of the polymeric blends to give improved properties and selectivity against the removal of specific wastewater organic contaminants. Finally, chemical-physical and structural-morphological characterizations of all dopant agents and functional membranes, as well as removal tests of model organic dyes, are described.

**Keywords**: advanced materials, mixed-matrix membranes, water remediation, functional nanofillers.

**Acknowledgements**: PON-MUR "Ricerca e Innovazione 2014–2020" RESTART innovative PhD funding project is gratefully acknowledged.

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# Eco-Friendly Antifouling and Fouling-Release Coatings for Blue-Growth Environmental Applications

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*Thematic Area: Materials & The Environment*

## Abstract

This work concerns the design and development of eco-friendly and innovative fouling release coatings to overcome the biofouling issue. In this context, the attention has recently switched to sol-gel based polymer coatings because they overcome some of the drawbacks of conventional coatings. This work, in particular, describes a simple method for creating an anti-fouling/fouling release sol-gel-based polymeric hybrid coating based on fluorinated [1] and long alkyl chain alkoxysilanes featuring varying length chains [2]. All experiments revealed that the F3-containing coating (either alone or in combination with F16) had a good anti-fouling/fouling release capability, preventing microbial biofilm establishment and adherence. In addition, this study reveals that appropriate functional groups in organic silanes, such as long-chain alkyl-silanes, had a significant impact on surface wettability, achieving hydrophobicity values equivalent to those produced with standard fluorinated precursors. It is crucial to highlight that none of the developed functional silane-based coatings release harmful substances into the environment, even if this result will be explored further and, in any instance, assessed in a long-term experimentation. The outcomes of this study will open the way for additional research projects that should focus on developing better sustainable FR coatings that are cost-effective, easy to apply, durable, stable, and able to be scaled up, by the use of improved multifunctional sol-gel based hybrid materials.

**Keywords**: antifouling, fouling release, hydrophobicity, wettability, sol-gel technique.

**Acknowledgements**: The research was supported by PON MUR 2014–2020 "THALASSA" project-(CUP ARS01_00293) and Ecosistema SAMOTHRACE – SiciliAn MicronanOTecH Research And Innovation Center.

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# Thiourea Formo-Phenolic Resins for Soft Metals Recovery (Au, Pd, Hg…) by Solid-Liquid Extraction

Claudine El Khoueiry [a, b], Stéphane Pellet-Rostaing [a], Iyad Karameh [b], Fabrice Giusti [a,]
Guilhem Arrachart [a], Bilal Nssouli [b].
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*Thematic Area: Materials and the Environment*

## Abstract

The main challenge in the extraction and recycling processes is the recovery of metals (radioelements, heavy elements, and precious elements) from ores, industrial effluents, or contaminated runoff water [1]. Liquid–solid extraction methods are an attractive alternative to the conventional solvent extraction process used for the separation and/or purification of different metals. As ion, exchangers or chelating systems, several organic, inorganic, and hybrid materials have been synthesized for selective ionic sorting. The introduction of specific ligands by covalent bands in the matrix of the resin allows increasing the capacity and the selectivity of the materials towards a specific metallic target [2].
Related to Pearson rules, Thioureas, sulfur analogues of carbamides, are excellent candidates for the extraction of precious and heavy metals. Therefore, the covalent introduction of thioureas, to the resin matrix could increase the selectivity and affinity for heavy and precious metals [3, 4].
In this project, a solid-phase extraction system was investigated for the extraction, valorization of noble, and heavy metals. Formo-phenolic resins were synthesized involving the condensation of formaldehyde with phenolic-thioureas under alkaline conditions. The resulting formaldehyde resole resins type were characterized and their adsorption capacity were investigated in regard to the extraction of noble and heavy soft metals. It was obtained that the material used provide a high capacity and selectivity, which make it as a potential candidate for recovery of precious and heavy metals by solid–liquid process.

**Keywords:** Chelating resin, heavy, noble elements, solid-liquid extraction; thiourea.

**Acknowledgements:** The authors would like to thank the French Embassy and the Lebanese National Council for Scientific Research (CNRS-L) for the co-joint funding of the project and the attribution of PhD's fellowship.

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# KEYNOTE SESSION 3

Nanomaterials and catalysts for energy Production

Chair/Co-Chairs: Dr. A. ElMoll, Dr. R. Djellabi, Dr. K. Plakas

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# Nanocatalysts for Hydrogen production: Recent and innovated technologies

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*Thematic Area: Materials and the Environment*

## Abstract

Hydrogen ($H_2$) emerges as a remarkable, ecologically sound, and alternative sustainable energy reservoir [1,2]. Its capacity to meet energy demands while bolstering environmental sustainability by integration into diverse sectors like fuel cells and energy storage systems is unparalleled. H2 generation entails multiple raw materials, encompassing renewable energy sources, conventional fuels, and cutting-edge technologies [3]. Among these, $NaBH_4$, a member of the borohydride family, garners significant attention for its potential in hydrogen storage and transport systems. This compound boasts a plethora of merits, including substantial $H_2$ storage capability, compatibility with eco-friendly strategies, non-volatility, non-flammability, and an exemption from elevated temperatures. The equation outlining H2 production through $NaBH_4$ methanolysis is as follows: $NaBH_4 + 4CH_3OH \rightarrow NaB(OCH_3)_4 + 4H_2$

The catalytic approach to hydrogen production through the methanolysis of NaBH4 has sparked considerable interest. Analytical reviews have underscored the role of transition and noble metals in catalyzing hydrogen production reactions [4–6]. Conversely, supported catalysts offer distinct benefits like augmented catalyst surface area, streamlined reaction mechanisms, and heightened catalytic process efficiency. This strategy aims to uphold the efficacy of metal-laden catalysts while mitigating expenses and environmental apprehensions. To this end, a gamut of catalyst structures encompassing noble metals, transition metals, and non-metals has been formulated. Among these alternative catalysts, carbon-based architectures, in particular, excel due to their robust catalytic performance, stability, and economic feasibility. Our recent investigations into carbon-based materials, derived from diverse carbon sources like textiles, hazelnuts, and poplar sawdust, have unearthed their potential as catalysts for hydrogen production, potentially finding utility as catalysts in fuel cells. Fabricated under an argon atmosphere at varying temperatures, these materials have been exhaustively characterized using advanced surface analysis techniques, such as XRD, XPS, SEM-EDX, TEM, and N2 adsorption-desorption techniques. Hydrogen production was conducted in a batch glass reactor. The outcomes of these measurements will be presented during the conference.

**Keywords**: carbon, catalyst, hydrogen production, nanomaterial, fuel cell

**References**:

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# Developments in the green hydrogen economy in the Netherlands

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*Thematic Area: Electrochemistry, Green Hydrogen production*

## Abstract

There are several opportunities to develop a hydrogen economy in Europe. For this, the European Union has developed a very ambitious plan called the REPowerEU to develop hydrogen and renewable energy generation from now until 2050 and beyond. To realize this ambitious plan, there need to be large-scale developments of the hydrogen supply chain (production, consumption, and transport of hydrogen), and these developments need to be started soon. To avoid the chicken and egg problem where the different parts of the hydrogen supply chain do not develop for fear of the other parts lagging behind, one component of the value chain has to lead the developments.

In 2021, the Dutch parliament approved the Hyway27 project. This project aims at developing a large-scale hydrogen pipeline that connects all the major industrial clusters in the Netherlands, as well as import and export connections. This so-called 'Dutch Hydrogen Backbone' is the first step of the European-wide ambition towards developing a 'European Hydrogen Backbone' that connects the hydrogen transport network in the whole continent. As a side benefit, the development of the Dutch Hydrogen Backbone has brought windfalls in the development hydrogen storage and consumption in the Netherlands, demonstrating the importance of a hydrogen transport network being developed in the country.

This presentation highlights the current state of matters regarding the development of a hydrogen economy in the Netherlands, and how the current developments are synergizing among each other as a result of the decision to build a Dutch Hydrogen Backbone.

**Keywords**: hydrogen economy, hydrogen in the Netherlands, REPowerEU, Hyway27, hydrogen in the gas grid.

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# ORAL SESSION 3

Structural, analytical & physical chemistry

Chair/Co-Chairs: Dr. A. ElMoll, Dr. R. Djellabi, Dr. K. Plakas

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# $CO_2$ Sequestration and Utilization into value added products by efficient biocatalytic system

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**(Not presented)**

*Thematic Area: Structural, analytical & physical chemistry*

## Abstract

Global warming and the major rise of CO2 into the atmosphere is a serious issue nowadays. To address such problems Carbon dioxide capture & storage (CCS) and carbon dioxide capture & utilization (CCU) are opt to be promising directions for CO2 reduction. Synthesis of a variety of value-added products from anthropogenic CO2 via enzymatic reduction mainly comprises an efficient multi-enzyme cascade system (MECS). In the present study, bacterial strains were isolated from the Hot water spring of Himachal Pradesh, India using the enrichment culture technique. After thorough screening for enzyme activity in the bacterial cultures, four isolates were selected. These strains have been identified based on physiological and molecular characteristics and four different enzymes namely Fomate dehydrogenase (FDH), Formaldehyde dehydrogenase (FalDH), Alcohol dehydrogenase (ADH) and Carbonic anhydrase (CA) have been partially purified. The enzymes were partially purified from a cell extract by ammonium sulfate fractionation, Acetone precipitation and dialysis. SDS-polyacrylamide gel electrophoresis was also carried out.
The biocatalytic Cascade system having these enzymes will help in the conversion of CO2 to CH3OH with the Cofactor oxidation of NADH to NAD+. The study presented here is one of the efforts of using enzymes as a means for CO2 conversion and to reveal the new possibilities to encourage them as efficient innovative pathways of technologies in the field of CO2 management.

**Keywords:** Carbon capture, enzyme, biocatalysis, global warming and Methanol

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# Sedimentology and depositional environment of Jhil Member Limestone, Gaj Formation, Miocene, Pakistan

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*Thematic Area: Agro Geoenvironment & Geomaterials*

## Abstract

The Gaj formation (Jhil Limestone) is located in the southern region of the Karachi arc in southern Sindh, Pakistan. Gaj Formation is known from Karachi arc and is widely distributed in this area. The Jhil Member Limestone is completely distinct from other lithostratigraphic divisions of the Miocene-aged Gaj Formation in terms of its color, texture, and structural features. However, the formation has been undocumented in terms of its facies and depositional setting. Now, to understand the link of facies, allochems, pore types and cements to the depositional setting in the lesser known Jhil Member of Miocene Gaj Formation in Pakistan. Two sections namely the Sona pass section with thickness of 47 m and Allah Bano section with thickness 30.5 m were used in this study. This limestone unit has been sedimentologically logged. Samples were collected and thin sections were made along with more detailed study of some samples using SEM-EDS. Our results show that there are three building blocks of these carbonates with dominant, corals, foraminifera and red algae. However, minor allochems include molluscs, brachiopods, bryozoans, oncoids and echinoids. Total nine microfacies are identified with range of textures from mudstone-wackestone to rudstone to bindstones. The environment of deposition ranges from off-reef, reef crest, reef front and lagoonal. These delicate coral facies along with other facies can guide us about sea level fluctuations and subsequent control by tectonics. This could lead us to identify and correlate this unit with similar age units (e.g., Dam Formation etc.) in the Middle East and other regions.

**Keywords:** Carbonate, reservoirs, coral reefs, facies, porosity.

# Day 2 - Friday 22 September 2023

## PLENARY SESSION 2

PL2: Trends in water pollutant monitoring with smart devices,

Pr. Najla Fourati, CNAM, Paris, France

Session description

One of the most valuable resources on earth is water. Witch all living need to survive. However, a number of factors like pollution, climate change, and human activity affect the quality of the water miserably. Therefore, it becomes extremely to monitor water quality to maintain its security and quality and avoid any negative health impacts on living beings. Traditional water quality monitoring techniques are expensive and time-consuming, and they frequently need specialists and experts. This plenary session focuses on the trends in water pollutant monitoring with smart sensors (chemical and biological sensors).

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# Trends in water pollutant monitoring with smart devices

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*Thematic Area: ELECTROCHEMISTRY, BIOELECTROCHEMISTRY & ENVIRONMENT*

## Abstract

Water pollutant monitoring is essential for safeguarding human health, helping ecosystem preservation, allowing timely corrective actions, and the sustainable use of water resources.
Trends in water pollutant monitoring with smart sensors include
i) miniaturization and portability for easy deployment in various water bodies, including remote and hard-to-reach locations [1],
ii) wireless communication, enabling real-time data transmission to centralized platforms for instant analysis [2],
iii) the use of sensors networks which permits to measure multiple parameters simultaneously, providing a more holistic view of water quality across different locations [3],
iv) employing artificial intelligence to process the large volumes of data collected by the smart sensors [4], and
v) remote control of specific parameters, enabling timely interventions when pollutant levels exceed certain thresholds, allowing quick response and preventive measures [5].
This presentation deals with the contribution of chemical and biological sensors, in general, and the electrochemical ones, in particular, to more efficient, accurate, and proactive water pollutant monitoring. Several examples are presented and discussed. The recent advances have demonstrated a promising future for safeguarding the environment.

**Keywords**: Chemical and biological sensors, Water on-site analysis, Water resources management, Wireless, Internet of things, Advanced sensing systems

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# KEYNOTE SESSION 4

Electrochemistry and the environmental

Dr. N. Fourati, Dr. A. ElMoll, Pr. K. Ouari, Dr. K. Plakas

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# Green Corrosion Inhibitors: Towards the Development of Non-Toxic Corrosion Inhibitors from Natural Sources

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*Thematic Area: ELECTROCHEMISTRY & ENVIRONMENT*

## Abstract

Corrosion is of paramount importance since it affects several areas (industrial, domestic, health safety, environment) and causes immense economic and human losses. Despite technological advances, corrosion still causes a large amount of damage in developing and even developed countries.

On the other hand, corrosion represents one of the major problems related to the use of materials, where industries, using toxic and dangerous techniques, generate serious and serious problems for humanity. Consequently, the development of non-toxic, inexpensive and effective, eco-compatible and biodegradable corrosion inhibitors is becoming an important issue today.

Current research is moving towards the development of non-toxic organic molecules to precisely and adequately mitigate corrosion. Some molecules can offer inhibitory properties, with respect to metals and alloys, in order to partially or completely replace traditional inhibitors.

This presentation covers topics regarding protection effectiveness, adsorption techniques, and inhibition mechanism of plant extracts intended for use as corrosion inhibitors. Several plant species are being considered for use as corrosion inhibitors. This presentation also discusses some synergistic effects of various plant extracts to mitigate corrosion reactions as well as study of technological applications of green corrosion inhibitors in different industries.

**Keywords**: Green Corrosion Inhibitors, advanced technology, Electrochemical process.

# ORAL SESSION 4

Electrochemistry and the environmental

Dr. N. Fourati, Dr. A. ElMoll, Pr. K. Ouari, Dr. K. Plakas

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# Electrochemical behavior of iron salen complexes with linear bridges

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*Thematic Area: Electrochemistry for the environment*

## Abstract

The present work aims to synthesis and full characterization of three complexes embracing ($N_2O_2$) ligands ($H_2L^1$, $H_2L^2$ and $H_2L^3$) prepared respectively by refluxing 2-hydroxy-1-naphthaldehyde with diaminoethane, diaminopropane and diaminopentane **[1-3].** These prepared compounds were characterized by elemental analysis, FT-IR, UV-vis spectroscopy and $^1H$, $^{13}C$ and Dept-135 NMR. The X-ray diffraction analysis of the ligand $H_2L^3$ explores that it crystallized in the monoclinic space group $P_2/c$ **[4].**

Electrochemical behavior of the complexes is carried out by cyclic voltammetry, on a glassy carbon (GC) electrode under nitrogen atmosphere, of iron complexes which showed reversible or quasi-reversible cyclic voltammograms responses involving a single electron redox wave $Fe^{II}/Fe^{III}$ **[3],** the diffusion coefficients are determined using GC rotating disk electrode. The Levich plot, $I_{lim} = f(\omega^{1/2})$, was used to calculate the diffusion-convection controlled currents.

**Keywords**: Diffusion-convection, Electrochemistry, Iron complexes, Schiff base, X-ray structure

**References**:

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# Greatly improved the cleavage of C-H bond of methane via Ni cluster supported on NiCu (100) surface

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*Thematic Area: Climate Change, Marine and Coastal Ecosystem*

## Abstract

Finding a clean and sustainable energy to replace fossil fuels is a challenge for scientist, and one of the solutions proposed is hydrogen [1] which is the most abundant element in the universe but is not available in a gaseous state on Earth [2] and must be produced from raw materials such as water, biomass, and hydrocarbons [3] as the methane. Methane is the second most important greenhouse gas contributor to climate change following carbon dioxide. So, we should be paying attention to methane emissions. It is a high-quality fuel and significant chemical raw material that has been intensively studied for new applications and hydrogen production. In this work, Different dehydrogenation behaviors of $CH_4$ are detected and well understood using the density functional theory calculations based on plane-wave basis and pseudopotential in terms of electronic structures involved in the reactions. First, it optimized the cell structure before calculating $CH_4$ adsorption at different high-symmetry sites (bridge, top, and hollow). To analyze the stability of methane molecules, the adsorption energy have been determined for each site. Our first-principles calculations, the Ni adatom is found to serve as the active reaction center for the methane adsorptions with two hydrogens oriented toward this atom with significant adsorption energy value of 0.24 eV, while its fragments have a strong preference to bond on top Ni-surface. The reaction barrier of first methane dehydrogenation is remarkably reduced from 1.76 eV on flat Cu (100) surface to 0.59 eV on Ni cluster supported on NiCu (100) surface. In this work, we demonstrate that addition of a single active metal atom into inactive matrix would remarkably improve the catalytic reactivity. The addition of Ni adatoms above CuNi(100) surface improves significantly both the thermodynamic and the kinetic proprieties of methane first dehydrogenation.

**Keywords**: Adsorption, Catalysis, CH4 dissociation, DFT, Ni doped Cu (100) surface.

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# KEYNOTE SESSION 5

Water resources, AgroHydrology and Sustainable environment,

Dr. N. Fourati, Dr. A. ElMoll, Pr. K. Ouari, Dr. K. Plakas

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# Challenges in the implementation of circular economy (CE) in the water sector - recovery of water and raw materials

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*Thematic Area: Water resources, AgroHydrology and Sustainable environment,*

## Abstract

The circular economy (CE) is already a well-known concept in Europe and worldwide. Currently, it is indicated that CE should be implemented in all sectors of the economy, as part of the pursuit of sustainability, which will ensure access to raw materials (renewable and non-renewable) for the current and future generation. However, individual sectors are adopting CE solutions at different speeds. One of the most important resources on the planet, that should be managed in the cycle, is water. Therefore, the water and wastewater sector are a key area where CE solutions must be developed and implemented. This creates many challenges for the sector's stakeholders, mainly companies that use water (in large quantities in production processes), as well as municipal and industrial wastewater treatment plants. One of the main challenges is to develop the concept of plants operating in closed systems, in which water and its accompanying raw materials, such as nutrients (phosphorus, nitrogen), are recovered. Management board, engineers and technicians with dedicated know-how are needed here. In addition, the challenge is to obtain funds to finance CE investments. Sometimes, as in the case of water reuse from municipal wastewater for agricultural irrigation, the challenge is the lack of trust of final consumer, as well as the low interest of recipients (farmers). Undoubtedly, various organisations (e.g. the European Commission) encourage active participation in the transformation process towards CE, which is why further development of CE solutions in the area of water and raw material reuse and recovery is expected.

**Keywords**: circular economy, CE, water, wastewater, raw materials, recovery

**Acknowledgements**: This publication was prepared based on results obtained under Subvention of the Division of Biogenic Raw Materials in the Mineral and Energy Economy Research Institute, Polish Academy of Sciences and project 'Water-CE-management in practice–developing comprehensive solutions for water recovery and raising awareness of the key role of water in the transformation process towards a circular economy (CE),' co-financed (EUR 280,000) by Iceland, Liechtenstein and Norway through the EEA and Norway Grants (https://www.wodogozowanie.com).

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# Enhancing Evapotranspiration Estimation in Remote Regions: Comparing Satellite-Based Techniques and Hydrological Modeling in a Tropical Monsoon River Basin

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*Thematic Area: Climate Change, Coastal, and Marine Ecosystem*

## Abstract

Accurately predicting evapotranspiration (ET) across many geographical and temporal dimensions for efficient irrigation water management and hydrometeorological investigations has grown more challenging due to having limited access to meteorological data in numerous remote places. Understanding ET becomes essential for efficient irrigation water management and hydrometeorological studies as climate patterns shift. This study addresses this problem by evaluating various indirect ET estimation methods. These include remote sensing methods based on satellite data like the semi-distributed variable infiltration capacity (VIC-3L) land-surface model and the moderate resolution imaging spectroradiometer (MODIS), Sentinel, and Landsat. These approaches are compared with two well-known ones: the Penman-Monteith (PM) equation method and the crop coefficient method. The study is carried out in eastern India, an area predominately characterized by paddy agriculture, to explore whether regional or local controls influence the accuracy of ET estimates using VIC and satellite-based approaches in a tropical monsoon-type climatic river basin. The results show that ET predictions from the VIC model closely match those from calculations based on PM. However, the satellite data estimations significantly understate ET values and show irregularities probably caused by cloud cover and leaf shadowing. A genetic algorithm-based transformation is used to improve the practical usefulness of satellite-derived estimations, which raises the overall accuracy of ET predictions. This study, therefore, emphasizes the need for regional-scale standardization of satellite-derived products employing PM or lysimeter data. It also suggests the potential market for modifying the algorithms embedded within satellite-based ET estimation methods to improve their generalizability. On the other hand, the VIC model yields satisfactory ET estimates at the grid scale, suggesting its reliable applicability to global river basins. However, minor inconsistencies might arise at smaller temporal scales.

**Keywords**: Evapotranspiration, MODIS, Sentinel, Landsat, VIC model

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# Sustainable Water and Wastewater Status in the Gaza Strip: challenges and solutions

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*Thematic Area: Water resources, AgroHydrology and Sustainable environment,*

## Abstract

The Gaza strip is a small narrow strip located in the southern Palestine in the Mediterranean region that suffers from severe water and wastewater crises like most of the Middle East countries. The main water source in Gaza is the coastal aquifer, which is under severe stress due to over-extraction with 97% of its water quality does not fit World Health Organization for drinking water, in addition to salination, and wastewater contamination. Climate change is further exacerbating water scarcity by reducing rainfall and increasing temperatures. This research assesses the current situation of sustainable water and wastewater management in the Gaza strip, identifies challenges and barriers to sustainability, and provide potential solutions and strategies. Further, it also examines the role of international initiatives and collaborations in addressing these challenges. All these challenges have impacted severely public health, sanitation, agriculture, and the economy. However, and in spite of these challenges a number of potential solutions and strategies for achieving sustainable water and wastewater management in Gaza have been implemented while others are being recommended by this research which includes:

Implementing and advocating for integrated water resource management, desalination technologies, improving wastewater treatment and sanitation services through decentralized wastewater treatment systems, implementation of wastewater reuse, exploration of the water-energy-food nexus, community-based water management, and economic models for water pricing and subsidies.

Strengthening institutional and governance capacity for sustainable water and wastewater management. International initiatives have played a role in addressing Gaza's water and wastewater challenges, however more initiatives are needed to ensure sustainable solutions. Coordinated efforts from all stakeholders, including the Palestinian Authority, community engagement, and the international community, are essential to achieve this goal.

**Keywords**: Water, Wastewater, Sustainable Solutions, Desalination, Treatment

# KEYNOTE SESSION 6

Materials and the Environment,

Chair/Co-Chairs: Pr. N. Fourati, Dr. A. ElMoll, Pr. A. Bratovic, Dr. K. Plakas

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# Advances in the eco-design and synthesis of materials for environmental applications

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*Thematic Area: Advanced Materials for Energy, Environment & Sustainability*

## Abstract

The development of innovative technologies for environmental protection and restoration has originated the need for new advanced materials. In the current communication, our background in the development of synthesized materials for environmental applications is presented. In the last years, the synthesis of biochar and hydrochar from agro-industrial wastes under thermal and hydrothermal treatments have been exhibited as an encouraging technology for enhancing the circular economy cycle by reducing waste accumulation. Using these thermal treatments we generated valuable adsorbents, from lignocellulosic materials such as olive pomace, banana, … and their ability for the remediation of wastewater containing pollutants of emerging concern, such as pharmaceuticals, has been validated [1]. In addition, the materials tailoring, by nitrogen doping or metal doping in one pot synthesis process has been exposed as an appropriate step that modified their properties and enhanced their catalytic properties. These functionalized carbonaceous materials exhibit several good properties for electrochemical hydrogen production or being used in Advanced Oxidation Processes (AOP), such as the Fenton-based processes. In parallel, our research has been focused on the development of nanostructured materials as Metal-Organic Frameworks (MOFs) which are novel porous materials formed by the link-up of transition metal ions using organic ligands to bridge. The resourceful synthesis of mono- and bimetallic MOFs has provided exciting properties similar to carbonaceous materials and we have demonstrated their viability for being used as adsorbent and catalyst in different AOPs (Fenton-based process, photocatalysis, and sulfate radical-mediated oxidation).

**Keywords**: Metal-organic Frameworks, hydrochar, biochar, Advanced oxidation process, Hydrogen production.

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# Benign-by-design nanomaterials for sustainable applications

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*Thematic Area: Nanomaterials and Environmental Sustainability*

## Abstract

The design of benign and environmentally sound methodologies has been the driving force of scientists in recent years towards more sustainable methodologies.
Attractive and innovative protocols that nowadays are even part of industrial ventures including biomass-derived porous carbonaceous materials, designer nanomaterials for catalytic applications and catalytic strategies for biomass/waste conversion into useful materials, chemicals and fuels have been recently developed in our group in recent years. These topics have extensively covered the preparation and design of (nano)materials, biocatalysts and photocatalysts and their utilisation in heterogeneously (bio)(photo)(electro)catalysed processes, flow chemistry as well as in biomass/waste valorisation practices.
In this lecture, we aim to provide an overview of recent efforts from our group in the benign-by-design concept applied to nanomaterials preparation, with excelling applications in catalysis and energy conversion and storage.

**Keywords**: Nanomaterials, Green Chemistry, Sustainabilty, Catalysis, Energy Conversion & Storage

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# Smart Composite Materials for Environmental Remediations

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**(Not Presented)**

*Thematic Area: Materials Chemistry, Environmental Chemistry*

## Abstract

Nanotechnology has been an emerging area of research due to its versatile application in many research areas [1-3]. Nano-engineered materials including nanoparticles, nanofibers, and nanotubes have been used extensively in recent years. Environmental concerns have been noted mainly due to the discharge of organic and inorganic pollutants. Nanotechnology is fast growing on research and bringing sustainable solution in the minimization of the waste. This also minimize the risk of exposure and health hazards. With the development of industry, environmental pollution and energy shortages have raised awareness of a potential global crisis. So, it is urgent to develop a simple and effective method to address these current issues. Nano-engineered materials can be better solution in finding solution of environmental sustainability. The current talk will be focused on the past, current and future scenario of various smart composite materials environmental remediation.

**Keywords**: Smart, Composite, Remediation, Environmental, Materials.

**Acknowledgements**: Author wish to thank Durban University of Technology for providing the resources.

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# Smart and innovative multifunctional materials: from design and synthesis to sustainable applications

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*Thematic Area: Materials & the Environment*

## Abstract

Recently, nanotechnologies have shifted toward the development of hybrid nanomaterials and functional nanocomposites, which are distinguished by the presence of functional nanometric components or nanofillers dispersed in a polymeric matrix, resulting in increased properties compared to those of either starting component. The original concept is to create an enhanced nanohybrid or nanocomposite material that is appropriate as a surface coating or for other sustainable applications due to increased qualities such as: 1) antifouling or antibacterial; 2) flame-retardant; 3) drug release; 4) sensing; 5) mechanical resistance; and 6) pollutant absorption and degradation [1]. In particular, the incorporation of sensing functions into fabric textiles is a powerful approach toward the development of so-called "smart textiles", enabling the development of wearable sensors, i.e. novel systems characterized by main textile characteristics such as flexibility, biocompatibility, comfort, and mechanical resistance, capable of reacting and adapting to specific external stimuli from their surroundings [2]. This work will show in details the design, synthesis, and characterization of hybrid nanomaterials and multifunctional, innovative and smart nanocomposites based on functional nanoparticles and nanofillers dispersed in polymeric matrices and/or in combination with suitable dopants, used as-is or as coatings of various substrates, for uses in opto-electronic devices, sensors, catalytic processes, cultural heritage, environmental remediation, construction, blue growth, biomedicine and textiles. The setting up of totally green and eco-friendly synthesis procedures based on natural components or wastes to produce functional products that can also be recycled, will be underlined as a crucial step toward sustainability.

**Keywords**: sustainability, advanced multifunctional materials, smart textiles, sol-gel chemistry.

**Acknowledgements**: MICS (Made in Italy–Circular and Sustainable) Extended Partnership (PE00000004) project is gratefully acknowledged.

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# ORAL SESSION 5

Structural, analytical & physical chemistry

Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll

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# Assessment of the physiochemical potable water quality of Beirut and Mont Lebanon, Lebanon.

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(Not presented)
*Thematic Area: Environment and Natural Resources.*

## Abstract

The issue of water in Lebanon is considered one of the most important challenges currently existing, as there is a noticeable decrease and sometimes scarcity in the delivery of water to residential areas and public facilities, this coincides with an unprecedented high rate of pollution, whether it is from water in delivery pipes or bottled water that citizens was purchased to meet the shortfall in their needs and in order to obtain clean water at the same time. The data processed below are the results of the study carried out on drinking water on 79 water samples in Beirut and Mount Lebanon. Most element concentrations are within the accepted WHO range. Our study will be limited by just four variables, only sodium, Arsenic, Mercury and Calcium since their concentrations are outside the accepted range according to the WHO. Results of drinking water shows that 23% of sites have a high concentration of mercury. Mercury pollution has many sources.76 % of sites have a high concentration of Arsenic. 91% of sites have a low calcium concentration which makes the drinking water weakly mineralized.20% of sites have a high concentration of sodium, and 9% of sites have a high concentration of Calcium since the Lebanese geology is formed, essentially, of hard limestone which increases the hardness of the water. The presence of calcium is beneficial for the body, it can only alter the taste of water and promote the appearance of scale in household appliances. Agriculture, with its overdose of pesticides, industrial activity near cities has a large part of the responsibility, by getting rid of its toxic surpluses, paints, waste oil, etc. Domestic waste, sanitary waste, discharges of hospital waste, the evacuation of sewers into rivers, in urban areas or in the countryside constitute a scourge.

**Keywords**: Drinking water, heavy metals, Lebanon, pollution.

**Acknowledgements**: RBML Food Labs, Consumer Lebanon.

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# Development of multifunctional Diatomite-Based absorbents for the removal of toxic metal ions from aqueous solutions

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*Thematic Area: Environmental chemistry, Analytical chemistry, Water treatment*

## Abstract

Recently, soil and surface water contamination with toxic metals has become a major problem. Radionuclides and heavy metal ions are not biodegradable and tend to accumulate in living organisms, which leads to various diseases [1]. For this reason, it is necessary to develop effective treatment techniques to remove toxic metal ions from water. In this work, the authors synthesized a series of chemically modified diatomite-based adsorbents and assessed their removal performance of ecotoxic metal ions (Cd(II), Cr(III), Pb(II) and Sr(II)). Compared with other functionalization methods, the chemical modification approach has the advantages of raw material availability, good adsorption effects with high reusability. It provides a cost-effective material to capture toxic metal ions, including chromium (Cr) and strontium (Sr) from water solution. The essences of this new development are as following: Modification and changes of the surface features of natural minerals with the treatment of functional silanes: *N*-(triethoxysilylpropyl) ethylenediaminetriacetic acid and diethylphosphatoethyltriethoxy (Dit/-EDTA/-$PO_3H_2$)

Controlled selectivity of the surface properties of the diatomite-based adsorbents towards the enhancement of adsorption capacity. The effects of the diatomite modification have been studied using powder XRD, solid state NMR, FTIR spectroscopy, scanning electronic microscopy, EDX, acid-base titrations, etc.

Batch adsorption experiments were carried out for several metal ions (Figure 1). Raw diatomite shows a low adsorption capacity towards the metal ions studied, indicating that matrix has a negligible contribution for removal in the final adsorbent. In contrast, *Dit/-EDTA/-*$PO_3H_2$ have a high uptake of tested metal ions, which means that N– and P-loaded groups contribute mainly to the removal of metal ions. The results show that the sorption capacity of the adsorbents is directly correlated with the concentration of functional groups but does not have a direct relationship with the surface area and pore diameter.

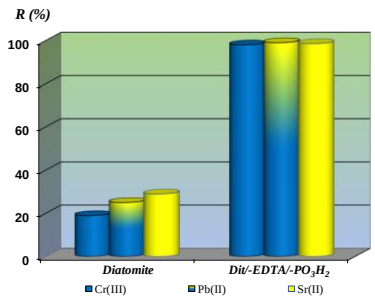


**Figure 1.** The effect of modification on the uptake of toxic metal ions at room temperature (*Conditions:* Initial concentration 200 mg/L; pH 7.0; L/S= 200)

The results illustrate that *Dit/-EDTA/-*$PO_3H_2$ could be a perfect candidate as an adsorbent for the removal of inorganic toxicants from aqueous solutions.

**Keywords**: About five key words or phrases in alphabetical order, separated by commas.

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# The Effectiveness of Two Hydroponically Alfalfa (Medicago Sativa L.) as compared to Open Field System in Mount Lebanon

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*Thematic Area: AgroGeoEnvironment*

## Abstract

This work aims to study the effect on the productivity and quality variation of alfalfa using the two different fertilization recipes: F1 (Samperio-Ruiz, 2009) and F2 (Jones, 2005) along with two different cultivation method in soilless: coconut fiber bag CF, Nutrient Film Technique (NFT) and in soil So. Number of leaves, stem length, number of flowers, crude protein, fiber and ash content of alfalfa plants were measured during the three cuttings time of the production cycle: 1st repetition (5 weeks), 2nd repetition (5 weeks) and 3rd repetition (5 weeks).

In the productivity phase and on day of harvest, results showed that during the three cuttings repetition, the number of leaves, stem length and number of flowers of alfalfa were in favor of the treatment of coconut fiber bags and the F1 fertilization recipe (CF1) followed by NFT. A good interaction that was noticeable at this combination level (CF1) with a best cutting found at cut 1 that plays a positive role on the productivity of alfalfa. In addition, these parameters are also positively affected by the method of Nutrient Film Technique (NFT) but not by the fertilization recipes F1 and F2 throughout the production cycle that show a negligible interaction.

As for the quality variation phase after harvest, the results showed that the crude protein and ash content are in favor of alfalfa grown in soilless CF2; CF1; NFTF1 and NFTF2 and therefore have a higher nutritive value than those grown in soil that had minimal effects on nutritional value. The F2 fertilization recipe was found better than F1 for quality variation while F1 turned out to be better in terms of productivity measurements than F2. As for fiber content, F1 was the most favorable and NFTF1 reported relatively higher fiber content values indicating better quality than coconut fiber bags CF1 and CF2. CF and NFT showed the highest effect on the quality variation. Concerning the cutting system, cut 1 showed the best results which reflects positively and had a large impact on chemical composition. The degradation of the quality is very clear in the alfalfa in So group.

In summary, alfalfa grown in soilless is more productive and higher in nutritive value than those grown in soil. The different cultivation methods associated with the different fertilization recipes succeeded in the production cycle and the quality variation of alfalfa. The CF1 treatment had successfully developed alfalfa plants and CF2 was slightly better in quality variation followed by NFT.

**Keywords**: Alfalfa, Coconut Fiber Bags, Fertilization Recipe, NFT, Productivity, Quality Variation.

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# Catalytic Degradation of Organic Dyes using Green-synthesized silver nanoparticles

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*Thematic Area: Materials & the Environment: Nanotechnology and Nanobiotechnology for Environmental Remediation*

## Abstract

Water is a vital factor for the continuity of life in its different forms on Earth. However, clean water suitable for drinking and irrigation has become scarce due to the high levels of inorganic and organic pollutants, pathogenic microorganisms and radionuclides. Therefore, the treatment of water is essential to preserve life on earth. Typically used methods of water treatments are expensive, time-consuming, incorporate the use of toxic chemicals, and produce hazardous by-products. Thus, an alternative process for the treatment of water was introduced based on green-synthesized silver nanoparticles. Compared to the chemical and physical syntheses of silver nanoparticles, the plant-mediated synthesis is environmentally friendly, cost-effective and energy efficient. In the current study, the aqueous root extract of *Saussurea costus* was used as green reducing agent to synthesize silver nanoparticles. The biosynthesized nanoparticles were characterized via different analytical techniques including UV-vis spectroscopy, FTIR, TEM, SEM, EDX, TGA, XRD and photoluminescence. The spherical, monodisperse, colloidally and thermally stable silver nanoparticles were assessed for their catalytic and antibacterial activities in the treatment of water. The catalytic degradation of methylene blue, phenol red, safranin O, Congo red, orange G and methyl orange were evaluated in the presence of sodium borohydride and the biosynthesized silver nanoparticles as a catalyst. Moreover, their antibacterial activity was assessed against *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Staphylococcus haemolyticus* and *Enterococcus faecalis*. The minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) were also determined.

**Keywords**: Antibacterial activity, catalytic degradation, green synthesis, organic dyes, *Saussurea costus*, silver nanoparticles

**Acknowledgements**: We would like to acknowledge the Kamal A. Shair Research Science Laboratory at AUB for assistance in using several analytical techniques.

# SPECIAL SESSION 1

Natural Resources management & Environmental Sustainability in Agriculture

Chair/Co-Chairs: Pr. N. Fourati, Dr. A. ElMoll

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# Hydrogeochemical study of Zahrani watershed (Lebanon) and its vulnerability to pollution (Application of RISKE method)

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*Thematic Area: Hydrogeology & Environmental Sustainability*

## Abstract

Water plays a major role in all aspects of life, and despite its importance as a natural resource, its qualitative and quantitative properties are constantly under threat due to irresponsible behavior of community members, mismanagement by local populations, institutions and government agencies. Thus, water is becoming scarce in Lebanon due to climate change and inefficient management. In the lack of solution, UNESCO estimates that Lebanon will experience a drought in 2050. The short rainy season that characterizes Lebanon, and the number of rainy days during a hydrological year, allow us to raise many questions about the capacity of this precipitation to infiltrate into the ground to replenish the aquifers with renewable water, especially after the stress of the aquifers during the long dry period.

The concept of IWRM (integrated water resources management) emerged over the last decade as a response to the "water crisis" due to population, water needs, pollution and climate change. To achieve this concept, the main objectives were to study the seasonal changes in piezometric level, as well as the seasonal qualitative changes in groundwater by tracing its chemical properties. Also, to study and identify area's most sensitive to pollution in the basin, characterized by karst features, and protect them.

Zahrani River catchment area is 102.7 $km^2$, has a Mediterranean climate and receives an average annual precipitation of 974 mm for the period 2009-2020. Water balance calculation indicates a deficit of the average storage volume equal to -15.69 $Mm^3$, while the deficit decreased to reach -10.33 $Mm^3$ when the hydrogeological areas outside the surface watershed are taken into consideration. Thus, the total area of Zahrani river reaches 120.63 $km^2$. Piezometric measurements, between flood period and low flow, carried out on 24 boreholes showed a drawdown varying between 20 and 30m. Additionally, most of seasonal chemical analyzes conducted on 28 water sources showed that the groundwater has overall calcium bicarbonate facies.

Results obtained by the final vulnerability map, calculated by multi-criteria overlaid maps RISKE method (Rocks, Infiltration, Soil, karstification, Exo-karst) indicates that most of the study area is of moderate vulnerability, influenced by two major parameters: Infiltration and karstification. Karstification of Zahrani watershed contributes to rapidly transferring pollution towards aquifers and springs which supply many municipalities in South Lebanon. Then, it is necessary to identify vulnerable areas to help decision-makers to take preventive measurements and decisions to protect water resources from pollution.

**Keywords**: Zahrani river, Hydro-geochemistry, Hydrology, Karst, Pollution, RISKE, Lebanon.
**Acknowledgements**: SLWE provide laboratory analyses, references and logistical facilities.

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# The submarine springs of Chekka: a prototype of non-conventional water to be projected on the entire Lebanese coastal aquifer facing climate change.

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*Thematic Area: Water Resources, Climate Change, Cartography GIS*

## Abstract

An airborne infrared radiometry detected temperature anomalies at sea and determined the exact location of water discharges. Fifty-four submarine springs were recognized along the Lebanese coast including 27 sources in the northern part of Beirut detected by the CNRSL (1997), and 27 south of Beirut detected by the FAO (1972).
In 2005, Z. Saad worked on the chemical and isotopic characterization of 22 coastal and 11 submarine springs. She concluded that Ca and Mg concentrations show that most of the submarine waters come from the Cenomanian-Turonian aquifer. Cl concentrations show that all waters are more or less mixed with seawater. Sulfate and nitrate concentrations show the possibility of wastewater infiltration into aquifers. The isotopic contents δ18O and δ2H show that the waters of coastal and submarine springs are very close to the meteoric waters of the Mediterranean regions, indicating rapid infiltration of water into the aquifers.
Studied for a long time, Chekka submarine springs in Lebanon are presented as being among the most important known undersea resources. Never questioned, the first estimates proposed an average flow of 6 $m^3/s$, among them at least 2.5 $m^3/s$ for the main spring during low flow. New technologies developed in France and United States to study submarine springs; their functioning and their aquifer were applied to these springs within the framework of a European project "MEDITATE". The main perennial spring was instrumented for monitoring its flow, salinity, temperature and pressure. First data indicate a minimum flow of approximately 60 l/s of brackish water during low flow. Its functioning is typically karstic, with wide variations of the flow, salinity and temperature of water. During low flow, high salinity is the consequence of sea water intrusion in karst conduits. Many water sites in the area, among them littoral and submarine springs were monitored for their geochemical characteristics. The hydrogeological basin was delimited: the rivers Asfour and Jaouz undergo losses in their crossing of upper Cretaceous limestone, reaching, according to the season, several $m^3/s$ on the whole. Terms of the hydrological balance of spring recharge basin gave an average flow of fresh water 2.15 $m^3/s$ on the whole, in agreement with direct flow measurements during low flow. These first conclusions question the possibility of direct exploitation of these submarine springs onshore or offshore. A permanent monitoring of the whole submarine springs is required along the overpopulated coastal aquifer to provide a sustainable exploitation of that non-conventional water facing the climate change and water scarcity.

**Keywords**: Karst, Coastal Aquifer, Submarine Springs, Non-Conventional water.
**Acknowledgements**: USJ, MEDITATE, CREEN.

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# ORAL SESSION 6

Structural, analytical & physical chemistry,

Chair/Co-Chairs: Dr. N. Fourati, Dr. A. ElMoll

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# An Approach for Energy Recovery from Closed Old Landfills in Algeria.

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**(Not presented)**

*Thematic Area: Bioenergy, Bioresource Technology & Environmental Sustainability.*

## Abstract

In the MENA region countries, the waste with approx. 50% of organic material is disposed of in technical landfills or dumpsites, depending on the available technical and financial possibilities. Currently, there are no other solutions and the situation will remain like the same for several years. Because of that, the number of landfills will grow and energy potential should be exploited. Algeria has more than 300 landfills [1], which can be used as sites for landfill gas and/or PV solar. However, advancements in landfill gas collection and utilization technologies have allowed for the extraction of methane, a potent greenhouse gas with significant global warming potential, and its conversion into a valuable energy source. In addition, energy recovery from closed old landfills through the installation of photovoltaic (PV) panels has gained attention as a promising approach to address waste management challenges while harnessing renewable energy. In addition, Algeria has a large program for solar energy and investments are available.

The aim of this study is developing a strategy in dealing with old landfills on the territory of Algeria. This strategy is based on energy recovery of landfill gas by valorisation through gas turbines or internal combustion engines, flaring, or by developing a Landfill Solar PV Array.

In conclusion, by repurposing these sites for solar power generation, we can transform them into environmentally friendly energy assets, reduce greenhouse gas emissions, and promote sustainable development. Continued support and investment in solar energy projects on closed landfills in Algeria are essential to unlock their full potential and accelerate the transition to a clean and sustainable energy future.

**Keywords**: Closed landfill, Energy, Landfill gas, PV-Solar, Waste management

**References**:

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# Influence of molar ratio and synthesis conditions on adsorptive properties of NiFe-LDHs nanomaterials for organic dyes and radionuclides removal applications

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**(Not presented)**

*Thematic Area: Environmental Chemistry, Radiochemistry & Materials*

## Abstract

Organic and inorganic pollutants commonly coexist in natural water environment, which has posed a great threat to human health and ecological environmental objects. Layered double hydroxides (LDHs) are known as anionic layered materials which are constituted by cationic layers of mixed metal hydroxides and charge-balancing anions in the inter-layer regions are beneficial for the formation of hydrogen bonding to the interlayer toxic ions and molecules.

In this work, *NiFe-LDHs* were synthesized varying the composition (Ni:Fe compositions of 1:1, 2:1 and 3:1) through hydrothermal method. The morphology and structure of the *NiFe-LDHs* were investigated and the adsorption capacity toward organic dyes (e.g. Methylene blue) and radionuclides were evaluated. This could provide basic information for the treatment of actual radioactive wastewaters.

The XRD patterns showed the characteristics planes of a *NiFe-LDHs* structure, displaying the (003), (006), (012), (015), (018), (110) and (113) planes of a hydrotalcite-like structure (JCPDS no. 40-0215). The sharp and intense peaks related to the (003), (006) and (012) as the most intense planes suggested good crystallinity, and it increased with the raise of the Ni content. In combination with the results of elemental analysis, the chemical formulas of $Ni_4Fe_1$-LDHs, $Ni_3Fe_1$-LDHs, $Ni_2Fe_1$-LDHs without interlayer water can be tentatively assigned as: $[Ni_{0.79}Fe_{0.21}(OH)_2]_2(CO_3)$, $[Ni_{0.66}Fe_{0.34}(OH)_2]_2(CO_3)$, $[Ni_{0.52}Fe_{0.48}(OH)_2]_2CO_3$. From SEM data, *NiFe-LDHs* consists of laminated aggregates and coacervates with a mean lateral size less than 100 nm, which are the typical hydrotalcite-like structure products.

The potential application of *NiFe-LDHs* for the removal of organic and inorganic pollutants in actual water matrixes was investigated. After 12 h, Sr(II) ions concentration decreased from 1 to 0.1 $mg \cdot L^{-1}$ and no Methylene blue was detected. Possible mechanisms were revealed, indicating that chemical adsorption was primary reactive species for the adsorptive removal of organic dye, and strontium species were removed by the combination of ion-exchange and surface complexation adsorption. Furthermore, *NiFe-LDHs* rendered a promising multi-functional material for the decontamination of polluted waters.

**Keywords**: Adsorbents, hydrothermal synthesis, brucite layer, radionuclides, water purification.

# KEYNOTE SESSION 7

Photocatalytic Materials for Environmental Applications

Chair/Co-Chairs: Dr. K. Plakas, Dr. A. ElMoll

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# Combination of photocatalysis with other emerging technologies for environmental applications

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*Thematic Area: Photocatalytic Materials for Environmental Remediation*

## Abstract

Photocatalysis as a single process suffers from many technology issues such as the slow kinetics, deactivation of photocatalysts, and production of toxic by-products. The intensification of photocatalytic technology process can be obtained via the combination of photocatalysis with several technologies providing synergistic effects and solving some technical issues. This talk aims to address the combination of photocatalysis with three other existing or emerging technologies namely, electrochemical, solar photothermal steam production and sonolysis. The mechanistic pathways of combined technologies for different environmental applications will be discussed and simplified. The talk also will discuss some real applications of combined systems, to understand the benefits of these combined systems for enhanced performance, low maintenance, long processing, and less technological issues.

**Keywords**: Sonophotocatalysis, Photocatalytic-photothermal, Photoelectrochemical, Environmental remediation, Energy production.

**Acknowledgements**: We are thankful for the support from Grant PID2021-123665OB-I00 and TED2021-129343B-I00 funded by MCIN/AEI/ 10.13039/501100011033 and, as appropriate, by "ERDF A way of making Europe", by the "European Union" or by the "European Union NextGenerationEU/PRTR". We acknowledge also Maria Zambrano Grants-2021URV-MZ-15.

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## Day 3 - Saturday 23 September 2023

# PLENARY SESSION 3:

STRUCTURAL, ANALYTICAL & PHYSICAL CHEMISTRY (T4)

Chair/Co-Chairs: Dr. K. Plakas, Dr. A. ElMoll

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# Mössbauer and magnetic characterization of technogenic particles in topsoil - emission sources evidence

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*Thematic Area: Atmospheric Chemistry & Environmental Pollution*

## Abstract

The aim of the study was to characterize, using Mössbauer spectrometry and magnetic analysis, the technogenic magnetic particles (TMPs) from non-ferrous metallurgy, cement, coke, glass production as well as long-range transport (LRT) [1] and compare the obtained data with previous results focused on iron mining and metallurgy [2]. The main characteristics of TMPs produced by Fe mining are: high values of concentration-dependent magnetic parameters, low values of coercivity, a significant contribution from coarse grains and a relatively high stoichiometry of magnetite. The most discriminative feature for TMPs generated by the glass industry is the abundance of goethite in the topsoil samples. The TMPs released by the Ni-Cu smelter and the Pb-Zn waste exhibit significant differences in the Mössbauer parameters, indicating different stoichiometry of magnetite for each group. Such variations are due to the replacement of Fe by other elements at tetrahedral sites in the case of TMPs released from the Ni-Cu smelter. The magnetic features of TMPs from cement production depend on the applied technology. TMPs characteristic for the LRT emissions contain a higher amount of finer fraction of low stoichiometry magnetite strong influence of the local pollution sources.

**Keywords**: Environment, emission sources, Mössbauer spectroscopy, magnetism, technogenic particles

**Acknowledgements**:
The study was partially funded by the National Science Center of Poland (project n° 2016/23/B/ST10/02814). Special thanks to Prof. Tadeusz Magiera, Prof. Beata Górka-Kostrubiec and Dr Michał S. Bućko for very fruitful work on the project.

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# KEYNOTE SESSION 8

Electrochemistry and the Environment

Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, Dr. Ridha Djellabi

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# Imperative Role of Natural Product Chemistry in Cosmeceutical R&D - Phytocosmeceuticals

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*Thematic Area: Structural, Analytical, & Physical Chemistry*

## Abstract

Natural product chemistry has been always attractive for drug and cosmetic industries as natural products can address very well to these industries. In accordance with consumer demand, cosmetic industry is looking for innovative, safer, more effective, and environmentally-friendly products. In this sense, a relatively new concept of cosmetics has emerged under the name of "cosmeceuticals or dermocosmetics/medcosmetics". Cosmeceuticals are briefly defined as subclass of cosmetics, which contain drug active substance or bioactive natural product with enhanced efficacy for therapeutic or cosmetic purposes. They are also described of combination of cosmetics and pharmaceutics or medical-grade cosmetics, which particularly enhance skin penetration and restorative effect of active ingredient in cosmetic formulations. Therefore, we have been working on research and development of novel phyto-based cosmeceuticals *via* extensive screening studies on plant extracts and pure natural substances using *in vitro* (enzyme inhibition, etc), *in silico* (molecular docking and toxicity screening), and cell-based assays. In this regard, an anti-acne formulation based on a number of plant extracts tested against *Propionibacterium acnes* has been developed by our group. Besides, an antimicrobial formulation as oral spray for mouth defense is currently a commercial product. For wound healing, we have been studying on nanofiber formulation loaded with plant extract. All our ongoing studies on discovering novel active natural ingredients for cosmeceutical purpose have so far yielded 3 patents, 4 patent applications, and commercialized a final product. In the present talk, examples and details of recent findings on phyto-based cosmeceuticals by our group will be underlined.

**Keywords**: Natural product chemistry, phytocompound, cosmetic, cosmeceuticals

**Acknowledgements**: The authors would like to thank to Scientific Research Unit of Gazi University for providing financial support to our projects (coded as 02/2019-31, 02/2016-01, and 02/2020-11) as well as partial financial funding for IEO from Turkish Academy of Sciences (TÜBA).

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# Engineering of *Bacillus thuringiensis* and its *cry* genes.

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*Thematic Area: Structural, Analytical & Physical Chemistry*

## Abstract

Increased use of products based on *Bacillus thuringiensis* in the world has led to increased awareness of the advantages, as well as the limitations of these biological insecticides. To improve the performance of *B. thuringiensis* based products, recombinant DNA technology has been used to develop new Bt strains for more effective pest control in various crops. When the target proteins are expressed in these recombinant strains, improved delivery, persistence and insecticidal activity have been demonstrated. At the Center of Biotechnology of Sfax - Tunisia, the Biopesticides Laboratory engineered *B. thuringiens* in order to develop new improved recombinant strains capable of competing with marketed biopesticides. The engineered *B. thuringiensis* strains focused towards the integration of protein of interest into the crystal and a more understanding of the mode of action of Cry toxins.

**Keywords**: *Bacillus thuringiensis*, *cry* genes, recombinant strains, engineering

**Acknowledgements**: This research was supported by a grant from the Tunisian Ministry of Higher Education and Scientific Research

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# KEYNOTE SESSION 9

Structural, analytical & physical chemistry

Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll, Dr. R. Djellabi

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# Urban green infrastructures towards sustainability and regulation of air quality

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Thematic Area: *Air quality monitoring and Climate Change*

## Abstract

The world is becoming overpopulated and increasingly concentrated in urban areas. This concentration of the population in residential urban centers has brought significant environmental problems, with a negative meaning such as: hot island phenomena in urban centers, increase in $CO_2$, pollution of the air and polluting gases in the atmosphere. In an urban environment, where trees and shrubs are base structure, main elements of GI, associated with flowers, grass, alleys, sidewalks, water bodies, wood works, sculpture, artistic/art works are the main elements that accompany and complement Green Infrastructure [2].

Emissions of volatile organic compounds from trees can contribute to the formation of ozone and carbon monoxide [4].

The main aim of this paper that we are presenting here is to reflect the correlations that exist between green infrastructures in residential centres and environmental components and more specifically with air in the function of sustainable development of urban inhabited centres.

The methodology used is as simple as it is meaningful, where through a deductive analysis of overpopulation factors, the green environment in residential urban centres, very important conclusions are reached about this very important phenomenon that appears today in the modern world of urban inhabited centres, with main aiming for a sustainable future

Trees and shrubs, GI in general, create a sustainable environment as well as improve environmental components and air quality through the selection of species that do not emit BVOCs, sequester CO2, production O2, absorb fumes and gases, even dust particles such as Pm10 or Pm 2.5, they create shade in the summer, they modify the rainfall regime, they create a pleasant environment, sweet noises around everything, they spread pleasant aromas in the atmosphere when the flowers bloom, they are habitats for elements of biodiversity...etc.

The study and the presentation will finally present a series of results that emerge from this building-population-environment confrontation and that will precede the giving of conclusions that are very important for the further progress of concrete actions to create and maintain sustainable environments in inhabited urban areas, as well as with the improvement of the most important environmental components and especially with the improvement of air quality in these urban regions. The above will be addressed in our study and presentation.

**Key words**: air quality, environment, green infrastructure, trees, urban forestry

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# Effect of Environmental Pollutants on Bee Products

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*Thematic Area: Structural, analytical & physical chemistry*

## Abstract

Bee products, including honey, pollen, royal jelly, and propolis were known for their nutritional and medicinal value and they play an important role in the diet and health of human. However, due to the environmental pollutants the quality and safety of these valuable bee-derived products has been overshadowed. The contamination of bee products can be caused by different sources such as beekeeping practices or by the environment. These contaminants have potential threats not only to bees and both also to consumers of bee products. Major environmental contaminants are the heavy metals, pesticides, organic pollutants, pathogenic bacteria and genetically modified organisms. Pollutants arise from beekeeping practices are mainly acaricides and antibiotics. One of the main concerns of environmental contaminants, especially pesticides are intended to protect crops, have negative impact on bee populations. They can cause collapse of entire colonies. The production of bee products is directly threatened by the reduced number of bee populations. The other major environmental problem is air pollution which indirectly effects the quality of bee products. These contaminations have negative impact on bee populations and reduces the nutritional value of bee products, potentially leading to substandard products. Bee products can contain residues of pesticides and toxins. These contaminants raise concerns about their safety for human consumption. The presence of such contaminants can undermine the health benefits associated with bee products. Key steps include the implementation of strict regulations should be hold by each country, to promote the sustainable agricultural practices and the reduction of overall pollution levels. In addition, beekeepers and consumers should be educated about the potential risks.

**Keywords**: Environmental pollutions, Beekeeping practices, Quality of bee products

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# Study of radiation-catalytic and radiation-thermal catalytic activity of polymorphic forms of $Al_2O_3$ in the water decomposition process

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(not presented)

Theme 3.3. Bioremediation and phytoremediation of environmental pollutants

## Abstract

Prevention of pollution and resource recovery involving wide variety of biological interventions using biodiversity is a Radiolysis processes in hydrocarbon systems have been mainly studied in the gas phase. The regularities of the influence of the phase state and composition of the mixture on the values of the radiation-chemical yield of molecular hydrogen have not been studied. In connection with the depletion of hydrocarbon reserves and an increase in demand for energy carriers, there is an increased need for identifying the regularities of radiation-chemical processes in water-hydrocarbon liquid-phase systems, which can serve as model systems for oil-contaminated water basins [1-5].
In this work, in order to reveal the regularities of the influence of the features of the crystal structure on the radiation-catalytic, thermo-radiation-catalytic action of aluminum oxide in the process of water decomposition, the kinetics of heterogeneous radiolysis of water in the presence of – α, -δ, -γ-$Al_2O_3$ at various temperatures and water vapor pressures was studied.

**Keywords**: Heterogeneous radiolysis of water, radiation-thermal catalytic, $A_{l2}O_3$ in the water decomposition process.

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# ORAL SESSION 7

Electrochemistry of Phytochemicals & Natural products

Chair/Co-Chairs: Dr. Ahmad ElMoll, Dr. Marta Pazos

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# Synthesis, performance and inhibitory efficacy of new Imidazole-Heterocycles for the chemical industry

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*Thematic Area: Electrochemistry & the Environment*

## Abstract

In this study, two inhibitors namely 6-Chloro -2-phenylimidazo[1,2-a]pyridine (Pyr1) and 6-Chloro-2-(4-Chlorophenyl)imidazo[1,2-a]pyridine (Pyr2) were used to investigate their inhibition ability toward mild steel corrosion in 1M HCl using electrochemical techniques and quantum approaches. The two inhibitors show corrosion inhibition efficiency of 98.35% and 97.57% for Pyr2 and Pyr1 respectively at the optimum concentration $10^{-3}$ M. This is due to the features of the substituent group and the effect of its emplacement in the phenyl ring [1–3]. The electrochemical measurements reveal that both the anodic and cathodic current are affected by these organic compounds so they are classified as mixed-type inhibitors with predominance cathodic character. The inhibited solution was analysed using UV spectrometer, it indicates a tendency to develop a complex between inhibitors and ferrous ions. The computational approaches were performed in order to examine the correlation between inhibition efficiency and molecular structure of the inhibitors Pyr1 and Pyr2.

**Keywords**: Imidazopyridine; corrosion inhibition; electrochemical techniques, Acidic medium.

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# A New Iron Complex: Active Catalyst for Homogeneous Cyclohexene Epoxidation.

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*Thematic Area: Organic electrochemistry and bioelectrochemistry*

## Abstract

A novel mononuclear complex [LFe(II)] (L = 1,2-bis ((E) -5-Bromo-2- hydroxybenzylidèneamino) benzene) was synthesized and characterized by elemental analysis, UV-vis, and FTIR. Density functional theory calculations have been performed on LFe(II) complex, using B3LYP/LanL2DZ. The DFT and TD-DFT results were found to agree well with the experimental data.

The electrochemical characterization of the studied complex was carried out by using the cyclic voltammetry (CV). The iron center gives a reversible redox couple near -300 mV corresponding to Fe(II)/Fe(III) process and the additional peaks in the CVs growing with the scan rate can be attributed to consecutive one-electron reduction of ligand.

The catalytic potential of this complex was examined by the oxidation reaction of aromatic substrate. Thus, the following reactive parameters were tested and optimized towards conditions with highest epoxide yield (97 %): oxidant type, solvent, cyclohexene-to-oxidant molar ratio, temperature, catalyst amount and time. The catalyst exhibited good catalytic activity in the oxidation of cyclohexene (95% conv. in 4 h). The major product was 97 % epoxide cyclohexene.

**Keywords**: Catalytic oxidation, DFT, TD-DFT, Electrochemical, Iron(II) complex.

# KEYNOTE SESSION 10

Nanotechnologies & Sustainable Nanomaterials for environmental Applications

Chair/Co-Chairs: Pr. K. Ouari, Dr. A. ElMoll

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# Enhancing Thermal Performance: An In-depth Analysis of Nanofluid Applications in Heat Transfer Technologies

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*Thematic Area: Nanotechnologies & Sustainable Nanomaterials for environmental Applications*

## Abstract

This comprehensive research undertakes an in-depth examination of nanofluids as a groundbreaking solution to enhance heat transfer mechanisms. Defined as colloidal mixtures of nanoparticles suspended in base fluids, nanofluids exhibit exclusive thermophysical properties that can be harnessed for remarkable improvements in thermal efficiency. The paper demystifies the core principles governing nanofluids, drawing attention to their unique attributes and the physics that modulates their functionality.

Key factors such as nanoparticle dimensions, shape, concentration, and base fluid selection are identified as determinants in shaping these properties. It underlines pivotal experimental and computational research validating the effectiveness of nanofluids across a wide array of heat transfer applications, ranging from industrial heat exchangers to electronic device cooling systems.

Equipped with superior thermal conductivity and enhanced convective heat transfer coefficients, nanofluids propose innovative tactics for devising thermal systems with augmented performance. Additionally, the paper discusses challenges and prospective strategies for mass production and efficient integration of nanofluids.

Despite nanofluids' tremendous potential, their application remains in the early stages, underscoring the need for rigorous R&D to fully exploit their capabilities. This exhaustive review aims to highlight the transformative potential of nanofluids in amplifying heat transfer systems' efficacy, offering insights into the prospects and obstacles in this captivating field of study.

**Keywords**: Heat transfer systems, nanofluids, thermal conductivity, enhanced convective heat transfer

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# Green Nanotechnology: Potential Approach for Clean and Sustainable Environment

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*Thematic Area: Nanotechnologies & Sustainable Nanomaterials for environmental Applications*

## Abstract

Nano photocatalysts (BiOXs and its composites) have been successfully synthesized using green hydrolysis method using phytochemicals. To obtain a better understanding of the results, the BiOX and their composites were also synthesized by hydrolysis method (without leaf extract) followed by their immobilization on Alumina ($Al_2O_3$)-based ceramic fiber sheet and activated carbon block as supporting material. The main objective of the present work was to eliminate the separation problem of the powder photocatalysts from the aqueous medium and evaluate their efficacy for the photocatalytic disintegration of organic contaminants in the long run. The synthesized photocatalyst was characterized using SEM, XRD, FTIR, UV-vis DRS etc, which suggested that the BiOX were successfully embedded in the host matrix of ceramic fibers and carbon block. The results revealed that the higher pH value was more favorable for bisphenol A (BPA) and Ampicillin (AMP) degradation, while the MO was completely degraded at all pH range. Moreover, the stability test was performed, and high stability of the immobilized samples was observed for five cycles without leaching out in the aqueous medium. The present study could offer new outcomes for advancing the large-scale applications of supported and sustainable materials for environmental remediation.

**Keywords**: BiOX, Photocatalyst, Ceramic fiber, green nanotechnology, clean environment

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# Pure and doped $TiO_2$ use to achieve germicidal action of nanocomposites

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**(Not Presented)**

*Thematic Area: Nanomaterials, Nanostructures and Environment*

## Abstract

Due to the superior ability of photocatalysis to inactivate a wide range of harmful microorganisms, photocatalysis is a versatile and effective process that can be adapted for use in many applications for disinfection in both air and water matrices. Additionally, photocatalytic surfaces are being developed and tested for use in the context of "self-disinfecting" materials. Studies on the photocatalytic technique for disinfection demonstrate this process to have potential for widespread applications in indoor air and environmental health, biological – agricultural and aquaculture applications, medical applications, pharmaceutical and food industry, wastewater and effluents treatment, and drinking water disinfection. Studies on photocatalytic disinfection using a variety of techniques and test organisms were published with an emphasis on various end-use applications of developed technologies and methods. This presentation would particularly focus on our recent achievements on fabrication and use of pure and doped $TiO_2$ photocatalysts based composite materials with antibacterial, antifungal, pesticide and antifouling properties. Various composites fabricated by electrospinning, electrospinning calcination and 3D printing techniques and their properties would be presented and discussed.

**Keywords**: antifouling, antibacterial, photocatalytic, nanocomposites, TiO2.

**Acknowledgements**: HMU contribution to this work was partially supported by NATO Science for Peace and Security Programme, grant G5868. IMT contribution was partially supported by the Romanian Ministry of Research, Innovation and Digitalisation thorough „MICRO-NANO-SIS PLUS" core Programme and MicroNEx, Contract nr. 20 PFE din 30.12.2021.

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# Preparation and Application of Layered Double Hydroxide Composites Modified with Thiourea Derivatives in Environmental Applications

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**(Not Presented)**

*Thematic Area: Environmental Chemistry, Geochemistry & Earth Materials*

## Abstract

Increasing environmental pollution arising from unsustainable industrial and anthropogenic activities diminished availability and quality of natural resources and caused great concern regarding their continuity and safety.[1,2] World Health Organization mentioned that there is a great need for developing effective and efficient methods for removal and detection of environmental pollutants especially HMs at very low concentrations.[3] Adsorption based techniques are the most eco-friendly, effective and efficient methodologies. In this respect, new "green" adsorbents such as layered double hydroxides (LDHs) with high sorption capacities are much required. LDHs -the lamellar anionic inorganic materials found in nature- with their highly controllable and facile synthesis and modification, their inherent properties (e.g., physical and chemical properties, high biocompatibility and ability to adsorb and concentrate life-relevant molecules in aquatic media) have played a great role for the origin of life in the world.[4] Therefore, inspired by nature, LDHs and functionalized LDHs have been exploited as bioinspired platforms to absorb and concentrate toxic substances and elements, molecules, and biomolecules within life-like compartments in bioremediation.[5] Herein we are reporting a new family of functionalized LDHs –namely ZnCr-LDH, ZnCr-DS-LDH and ZnCr-BT-LDH (BT: Benzoyl Thiourea)- obtained via green synthesis method from a new perspective to provide an effective and efficient solution to the current challenges and provide directions for future research.

**Keywords**: layered double hydroxides (LDHs), bioremediation, aquatic media

**References**:

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# SPECIAL SESSION 2

Bioenergy, Bioresource Technology & Environmental Sustainability

Chair/ Co-chairs: Pr. K. Ouari, Dr. R. Djellabi

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# Hydrothermal Liquefaction of Biomass for Biofuels, Chemicals and Bio-products - From Fundamentals to Applications

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*Thematic Area: Biomaterials, Waste and Biomass Valorization*

## Abstract

Hydrothermal liquefaction (HTL) is a promising thermochemical conversion technique to process wet feedstocks. The products of HTL include organic bio-crude, biochar, and non-condensable gases. Compared to other waste-to-energy conversion processes like combustion, gasification and pyrolysis, HTL is a promising route as it does not involve drying of the feedstock for moisture removal, which is usually a costly operation. Although HTL is a reasonably established process in the laboratory in litre-scale to process few milligrams to grams of biomass, it is yet to be employed on a commercial scale to process huge quantities of diverse feedstocks.

HTL is an important process in the Indian context for municipal solid waste (MSW) management. Indian MSW is unique as it is a heterogeneous, unsegregated mixture of bio-organic and bio-inorganic wastes. In this presentation, the development of HTL technology to convert a variety of feedstocks including biomass residues, micro/macro algae, polymers and MSW to fuels and energy will be presented based on the results generated at IIT Madras. Through a series of well-designed experiments, the optimum process conditions have been determined for different feedstocks to maximize the product yields and their quality. For organic-rich substrates like biomass, algae and MSW, ~350$^{o}$C and 30 min are found to be the optimum process conditions, whereas for polymers, higher temperatures upto 400-450$^{o}$C may be required. The addition of co-solvents like methanol, ethanol, glycerol and paraffin oil even at low concentration (10-30 vol%) is shown to improve the oil yield while also improving the energy efficiency of the process. This is also shown to liquefy the plastics at lower process temperatures. Some salient results from our previous and ongoing activities will be discussed. Specifically, the co-HTL of cellulose and polypropylene as model compounds of biomass and polymers will be discussed. The effects of temperature, residence time, co-solvent type (glycerol vs paraffin oil), and cellulose:polypropylene loading on the product yields and their quality will be thoroughly discussed.

**Keywords**: Hydrothermal liquefaction, circular economy, sustainability, cellulose, polypropylene.

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# Physical insight into ultrasound-assisted biodesulfurization

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(Not presented)

*Thematic Area: Bioenergy, Bioresource Technology & Environmental Sustainability*

## Abstract

Biodesulfurization has emerged as potential alternative to oxidative desulfurization and hydrodesulfurization. However, main impediment in commercial application of biodesulfurization process is its slow kinetics. Ultrasound irradiation (or sonication) has been reported to enhance the kinetics of biodesulfurization. The present study has attempted to establish the physical mechanism of this enhancement by identifying links between physics of ultrasound/cavitation and chemistry of biodesulfurization. The model reaction system comprises of dibenzothiophene (DBT) as model sulfur compound, toluene as model fuel and Rhodococcus rhodochrous cells (in free and immobilized form) as microbial culture. The investigation has three approaches: (1) fitting of experimental profiles of DBT oxidation to kinetic model using Genetic Algorithm, (2) simulations of cavitation bubble dynamics and (3) analysis of secondary structure of the intracellular Dsz enzymes (involved in metabolic pathway) by circular dichroism. It is revealed that strong micro-convection generated by ultrasound and cavitation induces conformational changes in the secondary structure of the enzyme, which augments their catalytic efficiency. Oxidizing radicals generated through transient cavitation also provides a parallel pathway of oxidation of DBT to sulfoxide and sulfone, which are intermediates of DBT metabolism. This assists faster consumption of DBT by microbial cells. The results of this study clearly demonstrate the role of physical and chemical effects of ultrasound and cavitation in enhancing metabolism of biodesulfurization. Similar have also been obtained for biodesulfurization using Horseradish peroxidase enzyme.

**Keywords**: biodesulfurization process, Oxidizing radicals, catalytic efficiency.

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2. Bhasarkar JB, Borah AJ, Goswami P, Moholkar VS. Bioresource Technology 2015; 196: 88–98.
3. Bhasarkar JB, Dikshit P, Moholkar VS. Bioresource Technology 2015; 187: 369–378.

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# Microalgal for Wastewater Treatment along with Biomass Valorization

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*Thematic Area: Biomaterials, Waste & Biomass Valorization*

## Abstract

Microalgae based bioenergy production has gained a lot of attention in recent years due to their inherent features such as clean, green and sustainable energy resource. For a sustainable production of bioenergy, microalgae fits very well into the biorefinery concept. However, high nutrients and fresh-water requirement are the critical constraints associated with the production of economically sustainable bioenergy feedstock from microalgae. Wastewater with substantial pollutants such as nitrogen, phosphorous, and organic carbon is considered as potential growth media for microalgal growth. This approach can simultaneously address bioremediation and generate high-value biomass feedstock. However, economically feasible production of microalgae for biofuel will only be achieved if co-products are also explored. After lipid extraction towards biodiesel production, lipid-extracted microalgae biomass (LEMB) contains significant amount of carbohydrates, proteins, N, P, and other micronutrients. Utilization of LEMB to produce diverse energy sources and extraction of high value co-products carry potential to make the microalgal biorefinery approach more innovative and economically feasible.

**Keywords**: Algae, wastewater, bioenergy, lipid

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# Waste to Energy: An Investigation of Fuel Properties and Application with Health Risk Assessment

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*Thematic Area: Bioenergy, Bioresource Technology & Environmental Sustainability*

## Abstract

Due to the growing environmental concerns and depleting fossil fuel reserves, the search for alternative and sustainable energy sources has become a paramount necessity. Among the innovative solutions gaining traction is the production of fuel from biomass and waste plastics. This approach not only addresses the challenges of waste management but also offers a promising pathway to reduce carbon emissions and create a more sustainable energy landscape. Biomass, encompassing organic materials such as agricultural residues, wood, algae, and even municipal solid waste, has emerged as a versatile feedstock for fuel production. Importantly, they can be carbon-neutral or even carbon-negative, as the carbon dioxide released during combustion is offset by the carbon dioxide absorbed during the growth of the biomass feedstock. On the other hand, waste plastics have garnered attention as a potential resource for fuel production. The vast amount of plastic waste that accumulates in landfills and oceans presents a pressing environmental issue. Converting plastic waste into fuel not only mitigates the problem of plastic pollution but also contributes to energy generation. Therefore, the production of fuel from biomass and waste plastics holds significant promise for sustainable energy generation and waste management. By utilizing these resources, we can reduce our reliance on finite fossil fuels, minimize plastic waste accumulation, and mitigate carbon emissions. However, the widespread adoption of these technologies requires further research and development, as well as supportive policies and investments. As we strive to create a more sustainable future, the innovative use of biomass and waste plastics as fuel sources marks a crucial step towards achieving a cleaner, greener energy landscape. In this study, we have investigated the co-pyrolysis of biomass and waste plastic for the production of fuels and their potential applications for possible replacement of fossil fuels including health risk analysis.

**Keywords**: Biomass, Waste Plastics, Fuel, Engine Performance

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# Hydrogen production from waste water: Ecological and economical point of view

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*Thematic Area: Bioenergy, Bioresource Technology & Environmental Sustainability*

## Abstract

Energy deficit, environmental pollution, climate change and water shortage can be classified among the major problems facing the world and are expected to continue to face in the near future. In light of these challenges, we offer a perspective on decarbonizing emissions from the wastewater sector and transitioning to more renewable energy sources. Indeed, wastewater is widely recognized as a potential source of energy [1]: a clean energy carrier, chemical feedstock and fuel, widely recognized for its role in decarbonizing the future energy system.
Considering such a comprehensive exposure to hydrogen production from wastewater, critical information of several emerging technologies, including their mechanisms and reaction parameters influencing the process and their future development prospects, are described in this presentation, taking into account the economic side. This presentation outlines also sustainable, low-energy means of producing hydrogen from wastewater using emerging technologies. The first part highlights the advanced wastewater treatment process, energy production and carbon neutrality. Then, different sewage sludge treatment processes were described to minimize environmental impacts and benefit from the resources integrated into wastewater. Finally, an overview of energy technologies based on wastewater, their technical performances, their technical-economic feasibility and their advantages.

**Keywords:** Wastewater, innovative technologies, hydrogen production, Sewage sludge, recovery, Anaerobic digestion treatments.

**Reference:**

[1] Xinghong Qu, 2022, Bio-hydrogen production by dark anaerobic fermentation of organic wastewater, Front. Chem., Vol 10, 978907, Sec. Catalytic Reactions and Chemistry

# KEYNOTE SESSION 11

Structural, analytical & physical chemistry,

Chair/ Co-chairs:Dr. A. ElMoll, Pr. K. Ouari

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# Biosurfactant from Serratia plymuthica as green and effective solution for the recovery of metals from CRT waste

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*Thematic Area: Nanotechnology & Nanobiotechnology for Environmental Remediation*

## Abstract

E-waste is the toxic legacy of this digital age with the fastest growth rate than any other type of waste (twice the rate of plastic waste). Nearly 43 million tons of e-waste was generated in 2016 and was 8% more than 2014. Metal recovery from waste can be very attractive because of the protection of these natural resources. Hybrid bioleaching method, comparatively a new technique entails the complimentary combination of both- chemical and biological leaching for efficient metal selective extraction from e-waste. It promotes using safer chemicals and metal-specific ligands with compatible microbes for better extraction of selective metals.

Chemical- Biological hybrid leaching involves a compatible combination of both microbe and ligand towards metal extraction. Microbe initially change the chemical environment of the ligand and improve its leaching capability. Then in the next phase it releases bio-surfactants as a stress tolerance mechanism. In the present program of working effect of hybrid leaching involving Lipopeptides from Serratia plymuthica (serratamolide) was studied. It was found that hybrid combination enhances the leaching capacity by 300% and biosurfactants additionally helps in removing the organic material present in the e waste.

**Keywords:** e-waste; gold; hybrid; hybrid, *Bacillus, Lysinibacillus*, thiourea

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# Environmental biotechnology trends in water resources conservation: microalgae based process

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*Thematic Area: Bioremediation and phytoremediation of environmental pollutants*

## Abstract

In recent years, water scarcity has become an increasingly serious global issue. A complex interplay between industrialization, globalization, and rapid population expansion has further exacerbated this critical concern. These factors have placed tremendous pressure on freshwater supplies across the globe. Furthermore, the subsequent release of many organic and inorganic pollutants into the environment has caused widespread contamination of water, posing serious threats to human and animal health.

The development of microalgae cultures offers some hope for a long-term solution, especially in the area of enhanced wastewater treatment. These microbes exhibit an innate capacity to digest sophisticated pollutants, making them crucial allies in the struggle against the escalating pollution catastrophe. Microalgae are simultaneously piqueing the scientific and business community's interest as a viable biological platform with a number of benefits. Their extraordinary capacity to store carbon dioxide, a major greenhouse gas, may be able to lessen its negative consequences. They are also a profitable source for a variety of useful chemicals, including those used in food, cosmetics, medicines, animal feed, and biofuels. The widespread use of microalgae cultures and their practical applications, however, are constrained by productivity and financial issues despite their potential. To maximize resource efficiency, a concerted effort has been made. This entails maximizing their enormous potential in the effort to combat environmental pollution while fostering developments in the production of bioenergy and value-added biomolecules. The viability and sustainability of these procedures will be considerably strengthened by our initiatives. Innovative approaches based on living microalgae are currently being implemented to combat water pollution and resource scarcity. In particular, (i) ponds with high levels of algae, where microalgae are cultivated in ponds and their absorption capacity is exploited to purify wastewater and generate valuable biomass, and (ii) photobioreactors, which provide controlled environments for microalgae growth while optimizing efficiency. There have also been successful approaches that use non-viable microalgae to improve water quality. As a result of these developments, microalgae have the ability to transform wastewater treatment while promoting resource sustainability.

**Keywords**: Microalgae, Cultivation, Wastewater treatment, Biomolecule production, Biorefineries, Bioenergy.

**Acknowledgements**: This work was supported by grants from the Tunisian Ministry of Higher Education and Scientific Research.

# ORAL SESSION 8

Agro-Geoenvironment, Agrochemistry & Biogeochemistry

Chair/Co-Chairs: Dr. Ridha Dejellabi, Pr. K. Ouari

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# Climate changes and riparian forests – a case study from Albania.

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*Thematic Area: Air quality monitoring and Climate Change*

## Abstract

On our planet, earth, the presence of forests and water are among the most essential elements of natural ecosystems. About 31% of the land surface is covered by forests with about 4 billion ha, or 0.6 ha per inhabitant. Albania has 1 310 000 ha forests, 46% of surface. Presence of water observed in all globe: oceans with 97.08%; glaciers 1.99%, terrestrial continents, which used by humans about 0.62%, very low. Albania has many fresh water sources, 3 natural lakes: Ohri, Prespa, Shkodra, small reservoirs, and several lagoons along coast as Karavasta, Narta, Butrint and eight rivers. Hydrographic basin of Albania has an area of 43,305 km$^2$, within the territory of Albania there are 28,748 km$^2$. Forests has some specific correlations in hydrological cycle, in forests a part of precipitation reaches ground, a part of water kept by crown of the trees, a modification fall of precipitation on the ground.

The land in contact with water, are called as vital areas of interaction between land and water streams, land and forests adjacent to the fresh waters that influence and are reciprocally influenced. In this sense, a riparian forest (RF) is considered that part of the land in the vicinity of a body of water, stream, river, pond, lake, marsh, estuary or delta, channel, watercourse, covered with forests. RF of rivers in Albania has some specific features, presence of vegetation varies where they emanating, in middle or in delta near the sea. Albania, a Mediterranean country has many kinds of vegetation species in RF; close to the watercourse have species as alder tree, willows, poplars, plane trees, tamarisk, as herbaceous vegetation reeds, bulrush that grow in the presence of water, a little further from water flow find species as brambles, hawthorns, Judas tree, Spanish broom, and herbaceous species. In Albania have had quite good RF like in Shkumbin, Vjose, Seman, Mat, Devoll, Buna, Drini, Erzeni riveres

**Key words**: climatic changes, riparian forests, Albania, trees, vegetation, water.

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# Agro-environmental sustainability: the potential role of Green Nanotechnology

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*Thematic Area: Agro-Geoenvironment, Agrochemistry & Biogeochemistry*

## Abstract

Currently, mechanization, fertilizers and pesticides have offered agriculture a springboard towards hyper productivity, at the cost of transforming rural landscapes and depleting the environment and natural resources. On the other hand, central concerns in the world such as galloping demographics and climate change have directed researchers around the world towards Improving agricultural yields as the only solution to feed the planet while protecting the environment.

Indeed, nanotechnology could improve agriculture by optimizing: the water use; the earth; the fuel and the inputs. Also, the progressive recourse of producers to other modes of agriculture that are more respectful of the environment such as vertical farming and hydroponics

Add to this, green nanotechnology has the potential role of improving agriculture thanks to new nanotools for the control of rapid diagnosis of diseases, improving among other things the capacity of plants to absorb nutrients. Important interests of using nanotechnology in agriculture include specific applications such as nanofertilizers and nanopesticides to track product and nutrient levels to increase productivity without decontamination of soil, water

The interest of nanotechnology in agriculture will be present in this presentation with the current challenges of sustainability and climate change that researchers are exploring in the field of nanotechnology for agricultural improvement. The presentation also covers the use of new nanomaterials which can be used as: nanosensors, nanofertilizers, nano-remediators and nanocides.

**Keywords:** sustainable agriculture, green nanotechnology, nanofertilizer, nanopesticides, environment

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# Potential role on soil fertility of biochar obtained by date palm pruning residues at a farm level in United Arab Emirates

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*Thematic Area: Agro-Geoenvironment, Agrochemistry & Biogeochemistry*

## Abstract

The climate of the United Arab Emirates (UAE) is characterized by rare precipitation (60 to 120 mm per year), high average annual temperatures (25 to 28 °C) and intense evapotranspiration. The soils are mainly sandy, saline, with a low organic matter content. Therefore, their cultivation requires large volumes of water and high quantities of fertilizer. However, the application of biochar obtained from palm pruning residues to desert soils could increase soil organic matter [1], with many benefits: it could increase water and nutrient retention in soil (El-Naggar et al., 2019), improve the activity of soil biota [2], and improve soil structure [3].

Indeed, the combustion of organic matter in the event of a shortage of oxygen produces biochar, a porous material that can persist in the soil for centuries because it is difficult to degrade by microbes [4]. From an environmental point of view, this could reduce wind erosion [5], reduce the leaching of nitrates, heavy metals, etc. [6] and contribute to climate change mitigation through long-term CO2 sequestration measures (Lehman and Joseph, 2009).

This presentation concerns the sustainability of biochar production from palm leaves at the farm level. This on-farm production and use of secondary raw materials can improve soil fertility, reduce transport and help mitigate climate change. This work aimed to evaluate whether the biochar obtained from date palm leaves can be used as a soil amendment. Therefore, the chemical properties of palm biochar were compared with those of biochar's produced by different organic wastes.

**Keywords:** palm biochar, soil fertility, porous material, farm in United Arab Emirates

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# ORAL SESSION 9

Green Corrosion Inhibitors and Natural products

Chairs: Ahmad ElMoll, Marta Pazos

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# Green synthesis of silver nanoparticles using pineapple peel extract (Ananas comosus) and study of their anti-corrosion properties

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*Thematic Area: electrochemistry, environmentally friendly corrosion inhibitors*

## Abstract

Corrosion is a horrendous global problem leading to the failure of machinery and weakening of construction assemblies, thus directly threatening the lives of people and contributing to the depletion of natural resources upon its replacement. In this study, we report the green synthesis of silver nanoparticles (AgNPs) using pineapple peel aqueous extract (PAE) as a reducing and capping agent, and the application of the biogenic nanoparticles as efficient corrosion inhibitors in acidic media. PAE-AgNPs were synthesized under the developed optimal conditions, and characterized by FTIR, UV–Vis, TEM, SEM, DLS, zeta potential, TGA, XRD, EDX and photoluminescence. The total phenolic, total flavonoid and total carbohydrates contents in PAE were 29.91 mg GAE /g, 17.7 mg RE/g and 54.58 mg GE /g, respectively. PAE and PAE-AgNPs were tested as corrosion inhibitors of mild steel in 0.5 M HCl solution by potentiodynamic polarization measurements and electrochemical impedance spectroscopy. The inhibition efficiency of both inhibitors increased with inhibitor concentration and maximum inhibition efficiency of AgNPs was found to be 60.3 % at the optimum concentration of 2000 ppm at 30°C and that of PPE was 51.8 %. Theoretical fits of various isotherms, particularly Langmuir, Flory-Huggins, Temkin and kinetic-thermodynamic models were used to study the adsorption modes of the corrosion inhibitors on mild steel surfaces. The thermodynamic activation parameters suggested that the inhibition process was endothermic, the adsorption was physical, and the activation complex formation represented an associative step.

**Keywords**: Adsorption isotherms, electrochemical impedance spectroscopy, hydrochloric acid, Potentiodynamic polarization.

**Acknowledgements**: We would like to acknowledge the Kamal A. Shair Research Science Laboratory at the American University of Beirut for assistance in several analytical techniques.

Fifth International Symposium on
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# Kiwifruit peel extract-mediated synthesis of silver nanoparticles and assessment of its corrosion inhibition efficiency on mild steel in acidic medium

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*Thematic Area: electrochemistry, environmentally friendly corrosion inhibitors*

## Abstract

Biosynthesis of silver nanoparticles (AgNPs) was successfully achieved using kiwifruit peel extract as a reducing agent, and the corrosion inhibition efficiency of the prepared nanoparticles on mild steel in acidic medium was studied using electrochemical impedance spectroscopy and potentiodynamic polarization measurements. The synthesis took place at 50° C for 3 hours, and the color change from pale yellow to brown indicated the formation of the nanoparticles. UV-Visible spectroscopy showed a SPR band at 480 nm that confirmed the successful synthesis of AgNPs. FTIR ensured the richness of the plant extract with phytochemicals capable of reducing silver ions into silver metal. SEM and TEM images showed that the particles were spherical with average size of 52.42 nm. DLS indicated that the hydrodynamic diameter of the nanoparticles was 136.8 nm with a zeta potential of -21.19 mV. EDX ensured that silver is the primary component in AgNPs. TGA validated the existence of an organic layer on the surface of the nanoparticle. Total phenolic and flavonoid contents were 6.875 ± 0.661 mg GAE/g and 90.67 ± 1.552 mg RE/g, respectively. Inhibition efficiency of the corrosion of mild steel in 0.5 M HCl was studied at different concentrations of AgNPs using PDP and EIS analysis where the maximum inhibition was 60% at 1250 ppm of AgNPs. The adsorption mechanism was studied by fitting the experimental data into different adsorption isotherms. The thermodynamic activation parameters revealed that the inhibition was endothermic, and the adsorption involved physical interactions resulting in the formation of an activation complex through an association step.

**Keywords**: *Actinidia deliciosa*, Biological synthesis, EIS, Potentiodynamic polarization, Silver nanoparticles

**Acknowledgements**: We would like to acknowledge the Kamal A. Shair Research Science Laboratory at AUB for assistance in several analytical techniques.

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# Corrosion inhibition of carbon steel in acidic solutions using *Phaseolus vulgaris* L. extract as a green inhibitor

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*Thematic Area: Electrochemistry & Environment: Organic Electrochemistry & Bioelectrochemistry*

## Abstract

The anticorrosion properties of *Phaseolus vulgaris* L. aqueous leaves extract were investigated for the protection of carbon steel in 0.5 M $H_2SO_4$ and 0.5 M $H_3PO_4$ solutions using potentiodynamic and electrochemical impedance spectroscopy techniques. The extract acted as mixed-type inhibitor, and showed excellent inhibitory activity for the corrosion of carbon steel in 0.5 M $H_2SO_4$ and 0.5 M $H_3PO_4$ solutions, where it was found to be more effective in phosphoric acid than sulfuric acid. The adsorption of the extract on the surface of carbon steel obeyed Flory–Huggins, Temkin, and the Kinetic-Thermodynamic isotherms but not the Langmuir model. The calculated thermodynamic activation parameters indicated that the adsorption of extract molecules on the carbon steel surface involved a spontaneous physical adsorption process in both acidic media. The total phenolic, total flavonoid, total carbohydrates, and protein contents in the extract were 121.80 ± 3.65 mg GAE/g DW, 67.65 ± 2.31 mg RE/g DW, 2.67 ± 0.32 mg GE/g DW, and 0.122%, respectively. The richness of the extract in phenolic compounds rich in electron donating groups justified the strong adsorption of the *P. vulgaris* phytochemicals onto the surface of the metal. Thus, it is evident that *P. vulgaris* leaves extract constitutes a promising green corrosion inhibitor for the protection of carbon steel in acidic environments.

**Keywords**: Corrosion inhibition, EIS, FTIR, Thermodynamic parameters, Total phenolic content, Total flavonoid content

**Acknowledgements**: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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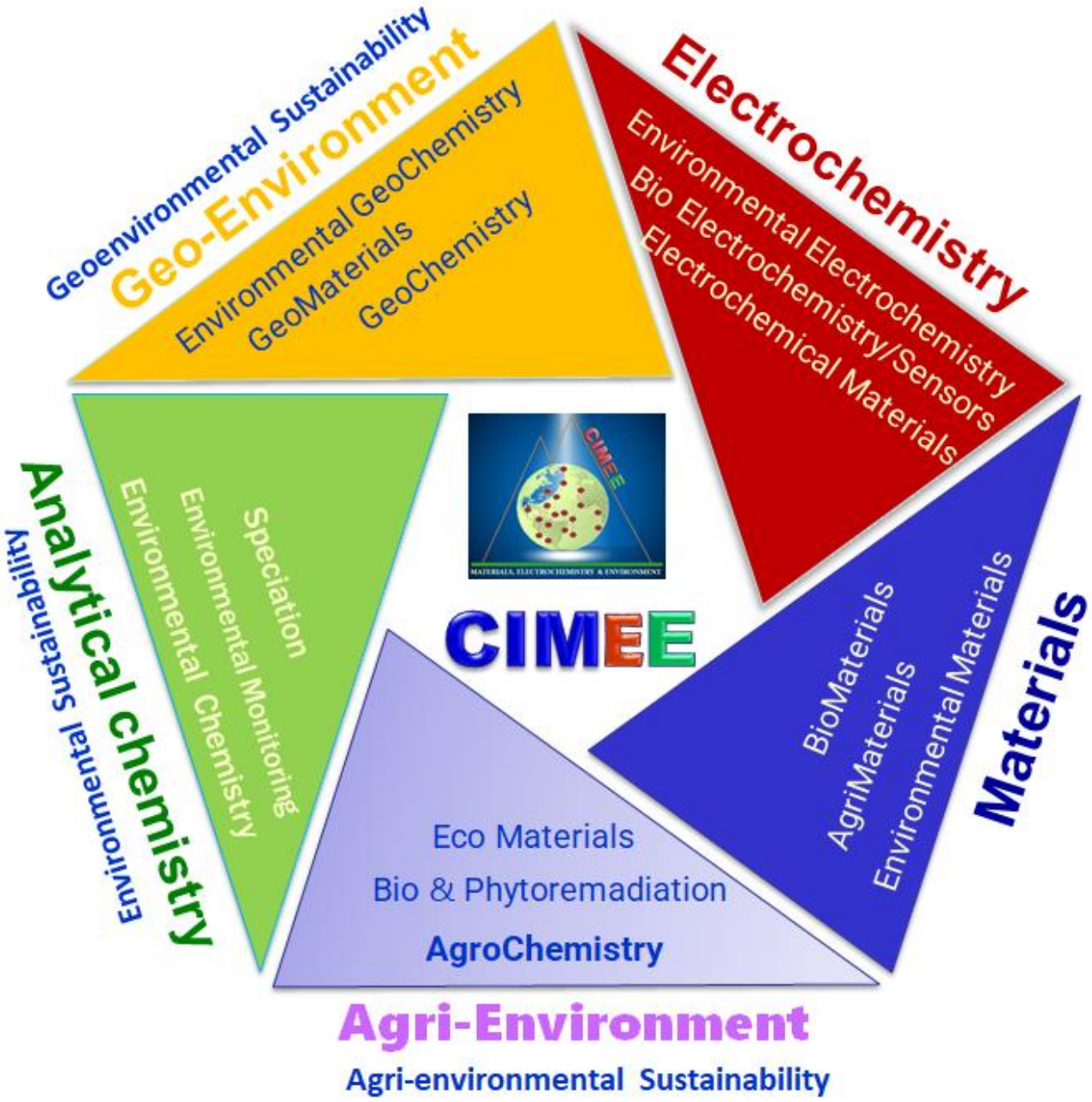
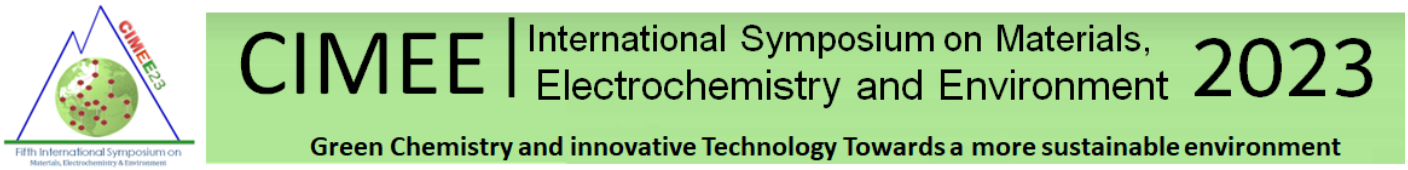
# CLOSING SESSION

Ahmad ElMoll, Kamel Ouar, Moufida Merzougui, Najla Fourati, Konstantinos Plakas, Tadeusz Szumiata




## CLOSING SESSION

**FIFTH INTERNATIONAL SYMPOSIUM ON MATERILS, ELECTROCHEMISTRY AND ENVIRONMENT**

**Cinquième Colloque International sur les Matériaux, l'Electrochimie et l'Environnement, CIMEE22**

**September 21 – 23, 2023 - LEBANON**

**CLOSING SESSION & CONCLUSIONS**

**Theme: Green Chemistry and innovative Technology Towards a more sustainable environment**

5th International Symposium on Materials, Electrochemistry and Environment (CIMEE 2023)

# Speech at the Closing Ceremony of the International Symposium, CIMEE23

Respected colleagues, Ladies and Gentlemen,

It is our great honor to spend the past three days with friends and colleagues from different countries. With your participation, the symposium successfully finished all its sessions. On behalf of organizing committee, I would like to extend our highest respect and most sincere gratitude to the joint efforts of all the participating, experts and guests, and our most cordial congratulations to the success of this International Symposium CIMEE23

However, countries all around the world are witnessing imbalance in sustainable development now. The fast-going urbanization and industrialization has put more and more significant pressure on natural resources, especially on land and water. Many challenges, such as climate change, waste pollution, energy and food safety, deteriorating environment, financial crisis, have posed threats to people's health and life, especially in Mediterranean region.

Sustainable Environment and planet health have been, and will always be, a challenge for all countries. It calls on us to strengthen our cooperation, extend our common ground and establish partnership relationship, so as to build up effective framework of sustainable environment and greener earth.

During the three days' meeting, we had in-depth discussions and communications on six major topics, we not only analyzed the general situation and existing problems of sustainable development, but introduced advanced experiences based on Materials chemistry and electrochemistry, exchanged ideas on cutting-edge theories and major practices of sustainable Environment. And we have proposed many constructive ideas and suggestions on greener, more efficient, more balanced and more sustainable development. These discussions made by all Guests and speakers here have shown remarkable insight on sustainable environment, moving efforts for building efficiency strategies and inspiring enthusiasm in the future development of sustainable environment.

Therefore, I firmly believe that the closing of this conference is not an end, but a new starting point.

Let's build on our current status and look ahead into the future, and build a high-end and prudent platform for global communication and cooperation, to make our effective themes beneficial to sustainable development and to people who have been enjoying and will enjoy green environment and healthy life. Below the 4 themes for the next edition.

T 1. MATERIALS & THE ENVIRONMENT
Physical and Materials Sciences, Energy and the Environment
Materials polymers and plastics, composites & hybrid materials, carbon materials, metal oxides.
Sustainable Materials: Synthesizing & studying novel materials originating from renewable resources.
Environmentally sustainable technologies.
Energy, Developing new materials to clean energy cycles t

T 2. ELECTROCHEMISTRY, BIOELECTROCHEMISTRY & ENVIRONMENT
Electrochemistry for the Environment
Electrochemical and environmental sensors, Biosensors technology
Organic electrochemistry & Bioelectrochemistry
Electrochemical nanosensors and their application
Electrochemical Materials for Environmental Applications

T 3. ATMOSPHERIC CHEMISTRY & ENVIRONMENTAL POLLUTION
Physics and chemistry for life sciences and the environment
Atmospheric chemistry and climate change, air pollution
Ecology, global environmental change, natural resources management
Physical geography, geochemistry, biogeochemical cycles, oceanography, climatology
Terrestrial ecology, land cover change and marine biology,
Physical Science, Analysis & Measurement: Quantify measurements of atomic & molecular behavior,

T 4. AGRO-ENVIRONMENT SCIENCE & AGROCHEMISTRY
Environmental biotechnology and Ecology
Agro Geoenvironment & Geomaterials
Agroecology and soil biology, Geochemistry & Earth Materials
Agro-materials, & Environmental geochemistry.
Biomaterials, Waste & biomass valorization
Biomass production and Bioenergy.

Dear friends, please allow me, on behalf of Organizing committee, to express again our sincere gratitude the support of all partners from Algeria, Greece, Morocco, Turkey and Tunisia for giving us this opportunity to host this Symposium and to the participation of all parties. Here, I take this opportunity to thank from the bottom of my heart our keynotes and all the speakers who added a good and generous experience to the conference,

I hope that all experts and guests present at this symposium can enhance friendship and strengthen cooperation, so that we can make joint efforts in pushing forward the sustainable development of the environment. We also sincerely hope that all distinguished guests and researchers here can participate in the great effort to go ahead in the publications the best papers in partner journals. We look forward to meeting you again in the next edition CIMEE'24, October 24 - 26, 2024.

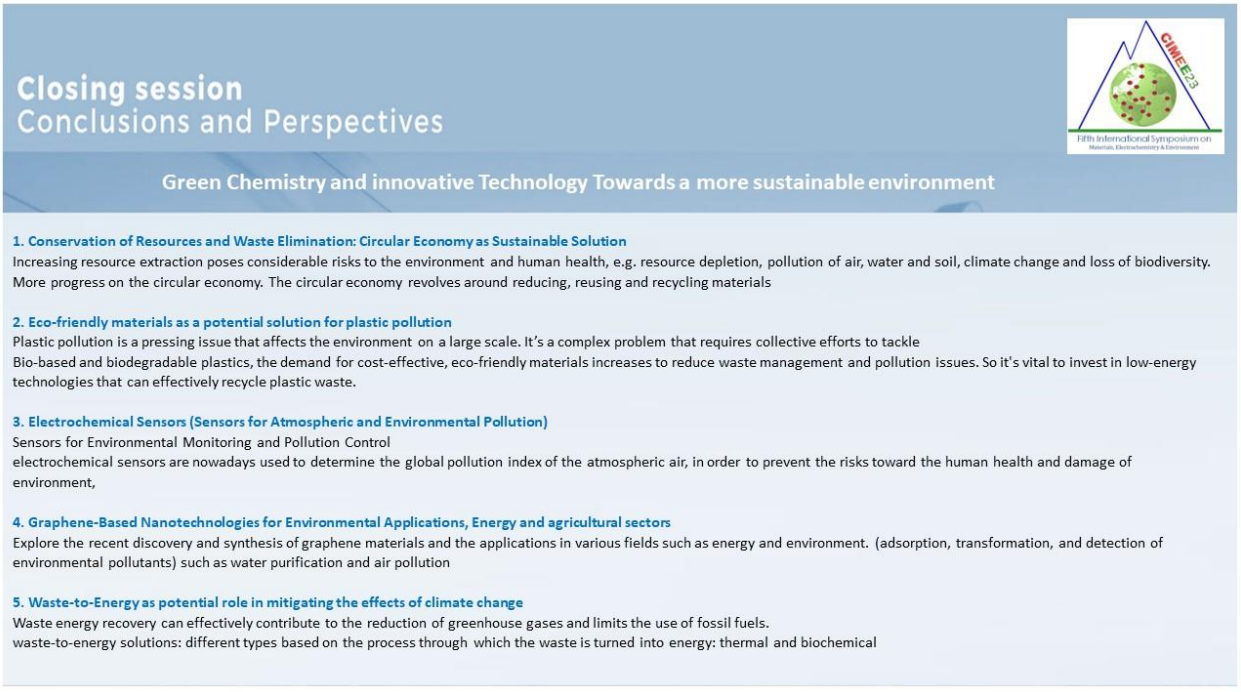
Thank you all!

CIMEE | International Symposium on Materials, Electrochemistry and Environment 2023

Green Chemistry and innovative Technology Towards a more sustainable environment

Dear colleagues, Dear participants,

Kindly find below the conclusions and perspectives at the closing session of the CIMEE'23 conference. Please send us your feedback regarding the 5 perspectives, your proposals and efficiency strategies and inspiring enthusiasm in the future development of sustainable environment for the upcoming edition CIMEE'24 will be held on 24-26 October, 2024



# Book of Abstracts & Program

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**Theme of the meeting:**

# Green Chemistry and innovative Technology Towards a more sustainable environment

## SYMPOSIUM PARTNERS


This book composes the abstracts of the plenary, keynote, oral and poster presentations of the 5th International Symposium on Materials, Electrochemistry and Environment (CIMEE23), held in AUF, Lebanon, from 21 - 23 September 2023. The abstracts are reproduced as accepted by the Scientific Committee of the meeting.



**Fifth International Symposium on Materials, Electrochemistry & Environment**
**FPH, DSST, Lebanese University, Lebanon**


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